

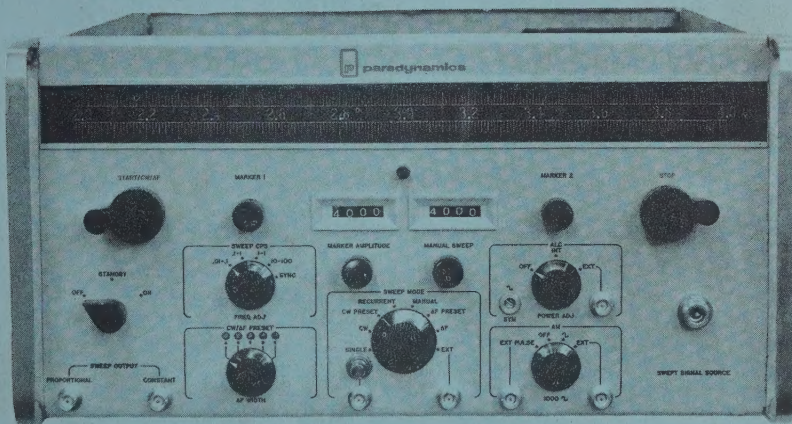
TC-4 AB

G. QUIRK

INSTRUCTION MANUAL

SERIES 880 & 881

MICROWAVE SWEPT SIGNAL SOURCE



MODEL NO. MW 881

SERIAL NO. 55108

MESL

Telephone: KIRKLISTON 277/278

MICROWAVE AND ELECTRONIC SYSTEMS LTD

OLD LISTON INDUSTRIAL ESTATE, NEWBRIDGE,
MIDLOTHIAN, SCOTLAND.

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MICROWAVE AND ELECTRONIC SYSTEMS LTD

Please reply to

Laboratories and Factory:

OLD LISTON INDUSTRIAL ESTATE,
NEWBRIDGE, MIDLOTHIAN,
SCOTLAND.

Telephone: Kirkliston 277/278

Sales Office:

17 HERMITAGE ROAD,
HITCHIN, HERTFORDSHIRE,
ENGLAND.

Telephone: Hitchin 50551/2

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WARNING

HIGH VOLTAGE

IS USED IN THE OPERATION

OF THIS EQUIPMENT

INTRODUCTION

This instruction manual contains general information, operating instructions, installation data, maintenance and troubleshooting procedures, parts list, and warranty for Paradyamics Swept Signal Sources, Series 880 and 881.

Series 880 and 881 Sweepers provide many modes of operation which can be selected from the front panel. For example, the SWEEP MODE Selector can be placed in "SINGLE", "CW", "PRESET", "RECURRENT", "MANUAL", " Δ F", or "EXT". Each position of the Selector provides advantages for specific usages. Before any sweep test is programmed, the operator should consult Section 2, Operating Instructions, to determine the best method of setting the versatile Series 880 (or 881) Sweeper for the particular test.

Although Series 880 (or 881) Sweepers can be operated in many modes and therefore, contain more programming circuits than other sweepers, all circuits are simple to understand and easy to troubleshoot...should the need arise. Before servicing the Sweeper, read Section 1, General Information, for a complete description of the Theory of Operation and the circuits contained in the unit. The Sweeper itself can be used to diagnose its own trouble. With the aid of the Theory of Operation and the Troubleshooting Guide (Section 4), the fault can quickly be located (and isolated).

Both Series 880 and 881 Sweepers are described by this manual. The basic difference between the two series is the location of a directional coupler and detector. In Series 881, the leveler circuit employs an internally-contained directional coupler and detector. Series 880 Sweepers are supplied without the directional coupler and detector, and the customer must provide these components as part of his test set-up.

Data for the Backward Wave Oscillator (BWO) employed in the Sweeper which contained this copy of the instruction manual has been added to the back of this manual.

FEATURES OF THE SERIES 880 & 881 SWEEPER

Operational features of Series 880 and 881 Sweepers include:

1. A choice of eight sweep or CW modes of operation. (See Paragraph 2-3-20)
2. Sweeprate Adjustments from 100 sweeps per second to one sweep in 100 seconds... even slower sweeprates are available with addition of an external capacitor. (See Paragraphs 2-3-24 and 2-4-1.)
3. Two frequency markers...with digital readouts. (See Paragraphs 2-3-4 and 2-3-10).
4. Internal or external power leveling, or operation without leveling.
5. A pen lift signal during flyback for the two slowest sweeprates.
6. A long, easy-to-read slide rule frequency dial.
7. Selection of sweep output to be compatible with either scope or recorder.
8. Five pre-set frequency stations for operating in either CW or swept mode.
9. An AM Control, an internal square wave, adjustable in on-off duration ratio, and an external AM provision for applying a pulse or other AM waveform.

SPECIFICATIONS

Model No 881

Frequency Range: 3.7 Gc/s to 8.3 Gc/s, sweep width continuously adjustable.

Minimum Power Output: 20 milliwatts. UNLEVELLED.

Residual FM: 100 Kc/s.

RF Frequency Drift: .5 M c/s per hour for +5°F Change in ambient.

BWO Part No.: PO- SE211B S^{No} 10041

BWO Warranty 2500 hr of operation (maximum of twelve calendar months from date of delivery) on a pro-rata basis.

Leveling System: Closed loop leveling system with power sample output driving a leveler amplifier.

A built in power sample is utilized in the "INT" position (MODEL 881), while an external accessory sampler is utilized in the "EXT" position (MODEL 880).

Markers: Two direct reading, in-line digital readout markers are provided. A marker amplitude control is also provided which varies amplitude from approximately zero to 100 percent modulation.

Marker Readout Resolution: Five places.

Frequency Readout: Fifteen inch linear scale. Independent controls for START and STOP frequency. RF output can be made to sweep either up or down in frequency.

An AM CONTROL Selector can be set to any of the following positions:

- a. "EXT PULSE": Oscillator biased below cut-off. +100 volts maximum provides full CW output during pulse.
Input Impedance: 10K ohms shunted by 30 uuf, maximum.
- b. "EXT AM": -25 volts maximum decreases RF output from maximum to zero (oscillator cut-off).
Response: DC to approximately 500 Kc/s.

c. "INTERNAL SQUARE WAVE": RF output is alternately zero (oscillator cut-off) and unmodulated CW value, adjustable 800 to 1200 cps.

d. "AM": Off.

A SWEEP MODE Switch controls the following functions:

a. "RECURRENT": RF output sweeps recurrently between START and STOP frequency settings with 1% linear sawtooth sweep. Sweep speed continuously variable in four decade ranges from .01 to 100 cps. A LINE SYNC position is also provided. In the two upper ranges, RF output is blanked during retrace. In the two lower ranges, the RF output is not blanked, and an x-y recorder PEN LIFT RELAY is provided.

b. "MANUAL": RF output can be manually varied between sweep end points without disturbing end point settings. Mechanical stops are provided in this position.

c. "SINGLE": A front panel button or 20 volt external signal triggers the single sweep.

d. "CW": Fixed frequency RF output can be manually varied over entire range of instrument using the START Control.

e. "CW PRESET": Five preset frequency positions which are independent of START-STOP, markers, and all other controls. Each position can be screw-driver adjusted to any CW RF frequency within the instrument range.

f. " Δf ": Symmetrical sweep about START frequency control setting. Sweep width adjustable $\pm 10\%$.

g. " Δf PRESET": Symmetrical sweep about each center frequency. Sweep width adjustable $\pm 10\%$.

h. "EXT": - 160 volts to - 250 volts required for full sweep width. DC to 10 Kc response.

Sweep Voltage Output: In CONSTANT, 1% linear sawtooth, 5 to 25 vdc peak amplitude, constant for any bandwidth.

In PROPORTIONAL, 1% linear sawtooth, 5 to 25 vdc peak amplitude, proportional to swept bandwidth.

Output Sweep Linearity: $\pm 1\%$

Series 880 & 881
Swept Signal Source

Sweep rate:	Continuously adjustable from 0.01 cps to 100 cps, in four decade steps plus potentiometer control. Sweep may also be synchronized to line frequency.
Sweep Range Extender:	Rear panel jacks for addition of external capacitance to provide slower sweeps to hours. Calibration approximately 20 seconds/ufd.
Amplitude Modulation: (Internal Square Wave)	RF output is alternately zero (cutoff) and unmodulated cw value, adjustable 800 to 1200 cps. On:Off ratio adjustable from 2:3 to 3:2.
Dial Accuracy:	$\pm 1\%$ of reading.
Residual AM:	At least 40 db below carrier amplitude.
Spurious Signals:	At least 30 db below carrier amplitude.
Elapsed Time Meter:	1500 hours.
AC Input:	110/220 $\pm 10\%$ volts, 1 ϕ . 50-60 cps.
Size:	8-3/4 x 17 $\frac{1}{2}$ x 21 $\frac{1}{2}$ inches, rack mounting brackets available.
Weight:	70 lbs, approximate; 99 lbs, shipping.

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SECTION 1
GENERAL INFORMATION

1-1 General

Series 880 (and 881) Sweepers provide milliwatt power outputs at frequencies within a given band. The precise output frequency can be adjusted and made to vary (sweep) across a range of frequencies. The rate of sweep can be selected for display on a standard Cathode Ray Oscilloscope (CRO, CRT, or Scope) or a recorder...or...by adding an external capacitor, can be slowed to any reasonable sweep rate.

The Sweeper provides milliwatt power while sweeping through a frequency band for determining a component's performance characteristic and displaying it on a CRO or recorder. The usual test set-up for measuring attenuation or insertion loss is shown in Fig. 1-1. VSWR can also be measured quickly and accurately as a function of frequency. The test set-up for vswr measurement is shown in Fig. 1-2. If the particular test to be set-up is unusual or other than attenuation, insertion loss or vswr, Paradyamics, Inc. offers technical assistance in preparing the sweep test. Call or write, Paradyamics, Inc., Huntington Sta., L. I., N. Y. attn: Engineering Dept. (516 HAmilton 7-7961).

NOTE: When viewing the output of the Sweeper on a scope, fine grain ripples may appear in the output. These ripples are not inherent in the Sweeper, but are due to reflection and transfer characteristics of long cables or waveguides, and to sensitivity variations of the detectors used. These ripples may be minimized in large measure by using well-matched transmission lines to connect the Sweeper to the devices under test, by keeping these transmission lines as short as possible, and by using frequency-insensitive (broadband) detectors.

1-2 Operation of the Sweeper

Each Series 880 Sweeper includes a Backward Wave Oscillator (BWO) tube to provide power at the output connector at the requisite sweep rate. (See Paragraph 1-4 for BWO Theory of Operation.) The BWO can be electronically tuned in frequency, and therefore, can sweep across a band of frequencies. The BWO output frequency variation can be linear (with time) if its helix sweep is characterized. Since a linear sweep is desirable, Series 880 Sweepers provide the required characterized voltage to linearly sweep the BWO helix.

In essence, the entire chassis of the Sweeper provides the various voltage levels required by the BWO. Some of these voltages can be varied from the front panel and are the adjustments which can be made by the operator.

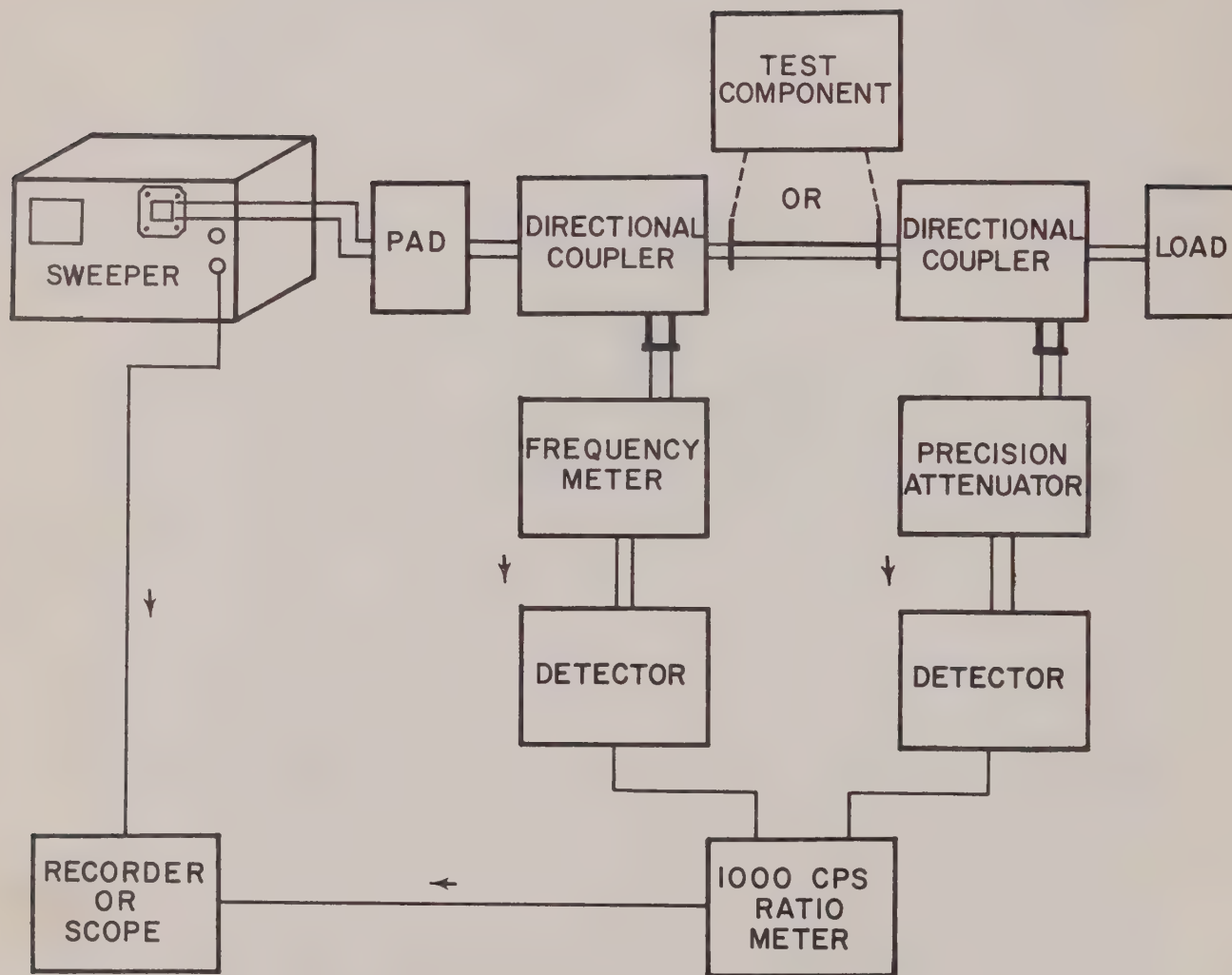


FIG. 1-1 ATTENUATION MEASUREMENT (INSERTION LOSS MEASUREMENT)

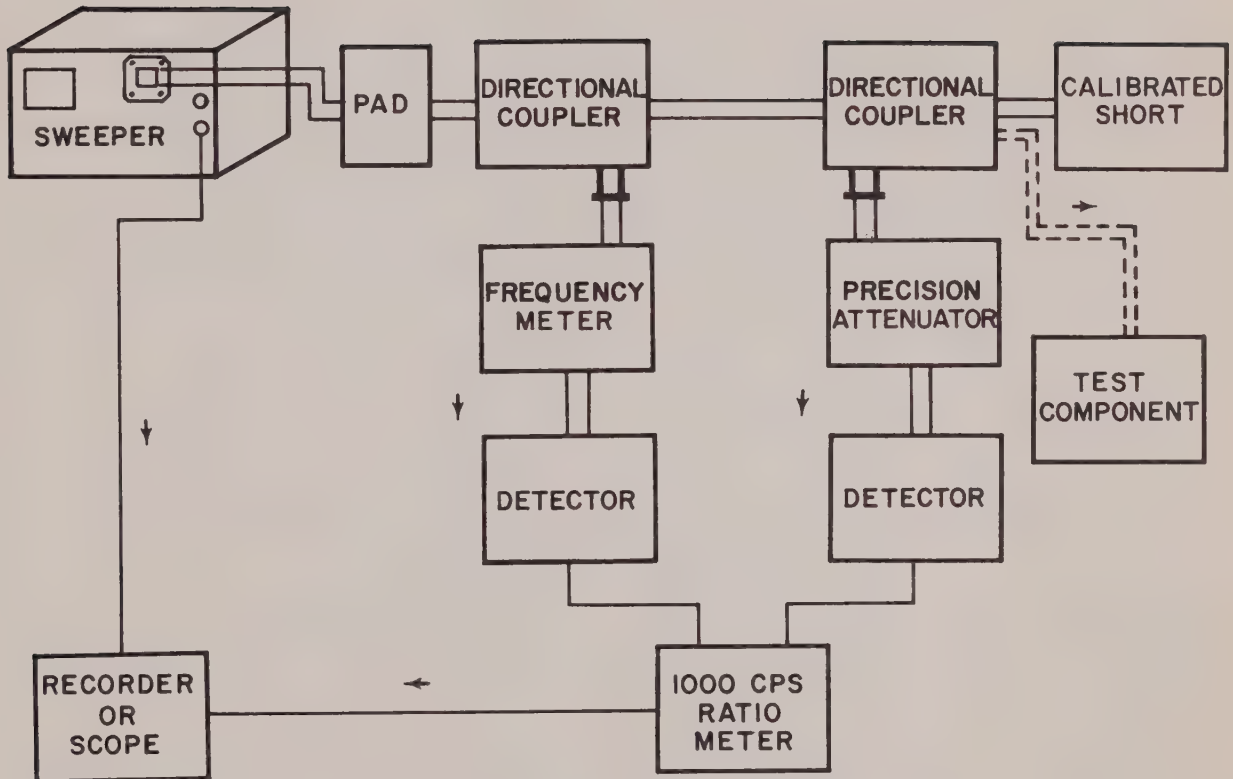


Figure 1-2. VSWR Measurement

From the front panel, the operator can adjust upper and lower frequency ends of the sweep, select either a fast or slow sweep rate to match a CRO or Recorder (respectively), and select either single sweep, recurrent sweeping, or cw operation (no sweeping at all). The complete operating sequence and its control is described in Section 2, Operating Instructions.

1-3 Sweeper Components

Series 880 Sweepers are built of decks or modules pertaining to individual functions in the Sweeper. Part numbers are assigned to components as follows: Prefix letter(s) describing the type of item, and a three-digit code number locating the deck and individual item are assigned. For example, components of the second deck would have X200 series numbers. The third (03) resistor (R___) of the second deck (2___) would therefore be numbered: R203.

Table 1-3

Component Designations

<u>Letter Code</u>	<u>Letter Code, Cont'd</u>	<u>Deck Code</u>
B Fan	S Switch	1-General Chassis (Usually Power Supplies)
C Capacitor	T Transformer	2-Filament Regulator
E Binding Post	V Vacuum Tube	3-Minus 300 Volt Regulator
F Fuse	W Plug, Line Cord	4-Sweep Generator
J Connector	Z Shaping Network	5-Helix Regulator
K Relay	CR Rectifier Diode	6-Marker Circuit
L Choke	DS Pilot Light	7-Leveler
M Meter	TB Terminal Board	8-Front Panel
R Resistor	VR Voltage Regulator	

Component functions are standard and well understood. Assemblies of components, however, perform services and provide outputs which are not standard, therefore, are described in Paragraph 1-5. In addition, the BWO is sufficiently uncommon to merit individual attention, see Paragraph 1-4.

1-4 The Backward Wave Oscillator

The basic oscillator used in Paradyamics Sweepers, the Backward Wave Oscillator, requires additional treatment for proper understanding. The BWO is one of a general class of tubes called Traveling Wave Tubes (TWT's) and the discussion of a BWO must start with a treatment of the TWT.

1-4-1 The TWT Operating Principle

TWT's are broadband amplifiers which generate and focus long, pin-like electron

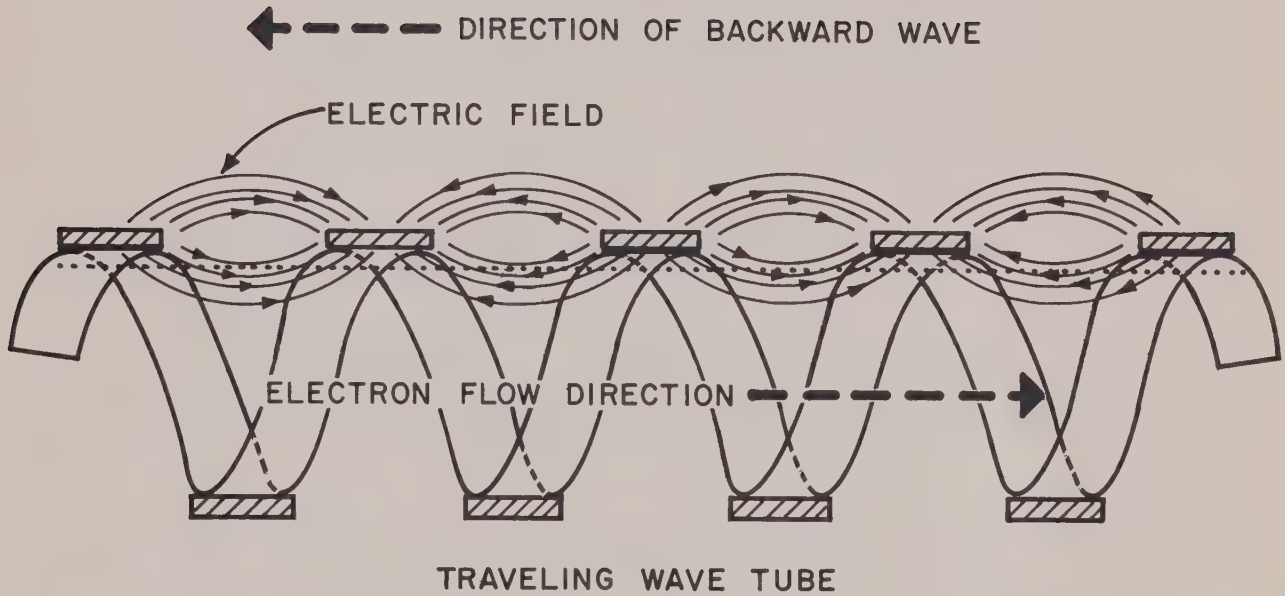


Fig. 1-4-1 CROSS SECTION OF HELIX, ELECTRON BEAM AND BACKWARD WAVE

beams. Passed through matching microwave structures and focused by strong magnets, the electron beam can amplify signals throughout the desired frequency band. The propagating structure provides an electric field axial to the electron beam. The phase velocity of the traveling wave approximately equals electron velocity. With convenient voltage levels at BWO anode and collector, electronic velocity is about one tenth the velocity of light. The propagating structure is, therefore, designed to provide or supply these slow waves.

One structure satisfying this requirement is a helix. Electrons in the helix wire travel (loop around) with the velocity of light. The axial component of that velocity is proportional to $\sin \theta$, where θ is the pitch angle of the helix. The resultant electric field surrounding the wire has only components parallel to the helix axis (See Fig. 1-4-1). This axial field permits interaction with the electron beam, producing velocity variations...bunching...of the electrons in the beam.

The RF signal is generally inserted at the gun end of the helix and the amplified signal is removed at the collector end. An RF attenuator, situated at a point midway between output and input, reduces signal strength, but does not affect the electron bunches. The electron bunches pass through the attenuator and generate a new RF signal on the latter portions of the helix. This attenuator prevents undesirable regeneration which otherwise might occur due to impedance mismatches at the output. Since the helix propagating structure does not disperse the electron beam, the wave velocity is essentially independent of frequency. This effect permits the TWT to amplify non-resonantly over a wide frequency band.

Since the electrons and waves travel at nearly the same velocity, the electrons experience forces which persist (interact) for relatively long periods. Relatively high amplification is thus available in spite of the low impedance of the non-resonant propagating structure.

1-4-2 The Bunching Process

Figure 1-4-2 shows an instantaneous distribution of axial electric field of the traveling wave at the entrance to the tube. The force due to positive E_z pushes the electrons to the right. Electrons arriving from the accelerating (electron) gun region may be assumed to be uniformly spaced over the RF cycle. An electron at position B experiences no axial forces. Electrons on either side of B, however, experience forces as indicated in the diagram...bunching the electrons about B. In contrast, position A becomes the center of the anti-bunch, or, the position of a minimum of electron charge density. As a result of bunching, the electron stream charge density is modified and appears as shown in Fig. 1-4-3.

1-4-3 Effect of Bunches on the Helix

As soon as the electron stream exhibits concentration of space charge in bunches, an induced RF current will appear in the helix. The electron beam, acting on the helix, can be treated as a series of bunches. The resultant effect is the sum of effects of individual elements. As in a directional coupler or antenna array, each

DIRECTION OF FORCE ON ELECTRONS

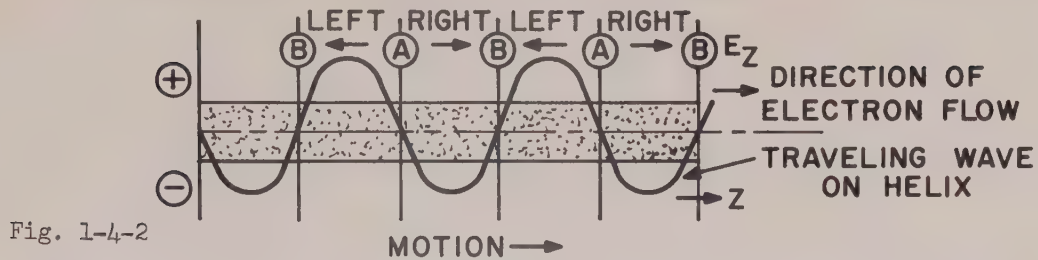


Fig. 1-4-2

INITIAL FORCES ON ELECTRONS IN THE TRAVELING WAVE TUBE.

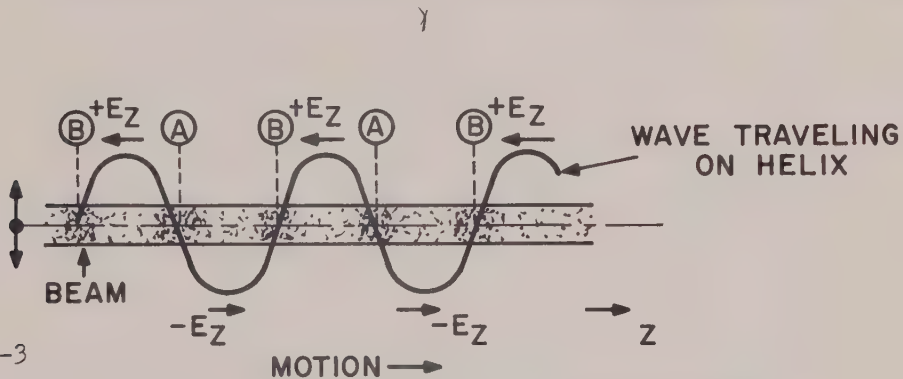


Fig. 1-4-3

INITIAL BUNCHING IN THE TRAVELING WAVE TUBE.

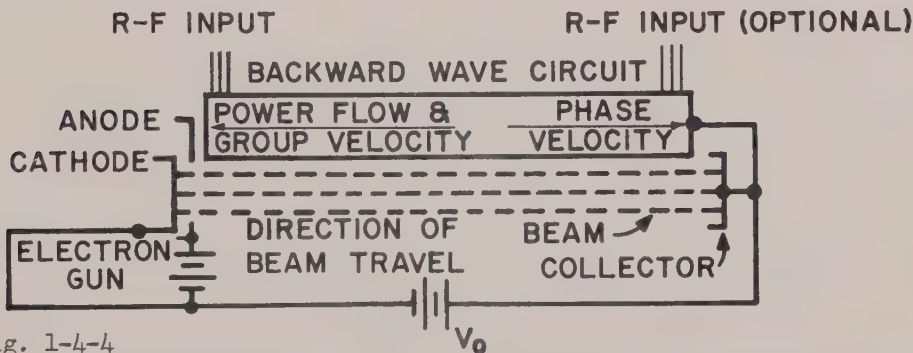


Fig. 1-4-4

SYMBOLIC REPRESENTATION OF THE BACKWARD WAVE OSCILLATOR OR AMPLIFIER

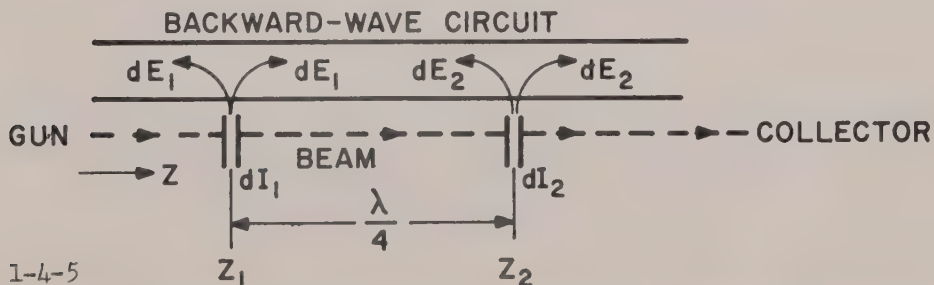


Fig. 1-4-5

INITIAL ACTION OF BUNCHED CURRENT IN A BACKWARD WAVE CIRCUIT

small current induces two wavelets in the helix...one forward and one backward. Since the electron and wave velocities are the same, the summation of wavelets in the forward direction results in a growing wave in this direction. The wave effect in the backward direction is almost cancelled. This occurs because each induced wavelet is in (time and space) phase with the exciting current. Detailed analyses indicate that the growing wave increases exponentially with distance down the helix.

1-4-4 The BWO

Any amplifier may be made to oscillate by feeding back signal from output to input. The BWO is a TWT with feedback supplied by backward wave interaction, a process of continuous feedback along the helix. As in any TWT, the electron beam is projected through a suitable slow-wave structure. However, the beam is now hollow and, different from the conventional slow wave structure of a TWT, the phase and group velocities are in opposite directions. Phase velocity now propagates in the same direction as the electron beam. Group velocity propagates opposite to the beam, or "backward" (hence the name BWO). See Fig. 1-4-4. In addition, waves propagating on the BWO helix are highly dispersive...or...the phase and group velocity rapidly vary as functions of frequency. With this condition, amplification or oscillation can exist only if the electron beam velocity matches the phase velocity. Thus, feedback is achieved and oscillation occurs at a frequency depending on beam velocity or beam voltage.

Amplification and oscillation of a BWO are the same as for a TWT. An RF signal, generated by random noise, is introduced at the gun end of the BWO. Electron velocity is adjusted to equal the forward phase velocity at the desired frequency of oscillation. Steady forces, acting upon the electrons, bunch current (as in the TWT). The action of the bunched current on the circuit is a summation of waves induced in the helix (and produced by incremental segments of current). See Fig. 1-4-5.

Consider, for example, current elements dI_1 and dI_2 which induce fields dE_1 and dE_2 as indicated. If current elements are spaced one-quarter wavelength apart, waves propagating in the beam's direction will almost completely cancel. The signal propagating opposite to the electron beam has a positive group velocity (collector to gun being considered positive) but a negative phase velocity. Wavelet dE_1 , therefore, in propagating one-quarter wavelength towards the collector, advances in phase by 90° , the relative phase between dE_1 and dE_2 becomes 180° ...causing cancellation of waves in the direction of electron motion. Similarly, wavelets induced in the backward direction are everywhere in phase and add constructively. Therefore, induced wavelets, traveling from collector to electron gun, add to produce a wave which increases with distance from the collector.

As in the case of the TWT, the total field is the result of all induced fields. The wave traveling in the direction opposite to the electron beam interacts with the electron beam producing positive feedback and oscillation.

1-5 Auxiliary Circuits

1-5-1 Sweep Generator Circuit (Ref. Fig. 1-5-1)

The voltage applied to the BWO helix is derived from a sawtooth (ramp), shaped and characterized to sweep the BWO output frequency linearly with time. The sawtooth voltage, linearly related to Sweeper frequency, represents output frequency at the Sweep Output Connector.

The sawtooth is developed as a charging voltage across Capacitor C 404 (or, for other sweep rates, C 404 and C 401, C 402 or C 403 in parallel with it). This sawtooth is sent to cathode follower, V 401B and from the cathode follower to V 403A through CR 403. In addition, the signal from V 401B also is placed on V 402B, another cathode follower.

The signal from V 401B is impressed on the grid of V 403A and when the sawtooth voltage waveform permits, V 403A suddenly conducts. As V 403A conducts, V 403B is cut off (since its grid is now driven negative). At this time, V 402A, a cathode follower which senses the output of V 403B, is driven into a current flow condition (almost saturation) and feeds back a signal to the grid of V 401A. V 401A now conducts...discharging C 404 and resetting the sawtooth.

The basic charging current for the bootstrap sawtooth generator capacitor, C 404, is derived from V 402B, through R 825 and R 807. By adjusting potentiometer R 807, the rate of charging of C 404 is altered...hence the frequency of sawtooth repetition is altered.

In RECURRENT, the sawtooth will self-generate and continue running until switched. In the other SWEEP MODE Selector positions, the sweep is initiated by either the line (in SYNC), an external source or the (SINGLE SWEEP) START Pushbutton. All these sweep mode triggers feed through CR 404 and initiate the sweep cycle.

Cathode Follower, V 402B, also provides the signal to the clamp circuit. Basic voltage references are maintained at (about) -160 volts and -245 volts by zener diode CR 406 and gas tube regulator, V 407, which are strung between the -150 and -300 volt supplies. The sawtooth output from V 402B is sent to the two references through two blocking diodes, CR 405 and CR 801. The signal is effectively clamped at both the high and low ends of the sawtooth...and balanced for symmetry...by V 407.

Since the sawtooth voltage represents Sweeper output frequency, selecting a voltage within the regulated differential of V 407 determines output frequency. The five presets and the Sweep START and Sweep STOP Potentiometers are, therefore, located in parallel with V 407.

With proper switching to schedule either single sweep, recurrent sweeping, preset frequency or sweep around a preset center frequency, or external sweeping, the signal derived in the circuit paralleling V 407 is fed to a cathode follower (either V 404A for Start signals or presets, or V 405A for Stop signals). Start signals are inverted to a negative-going sawtooth and amplified in V 404B...and strengthened in cathode follower V 405B.

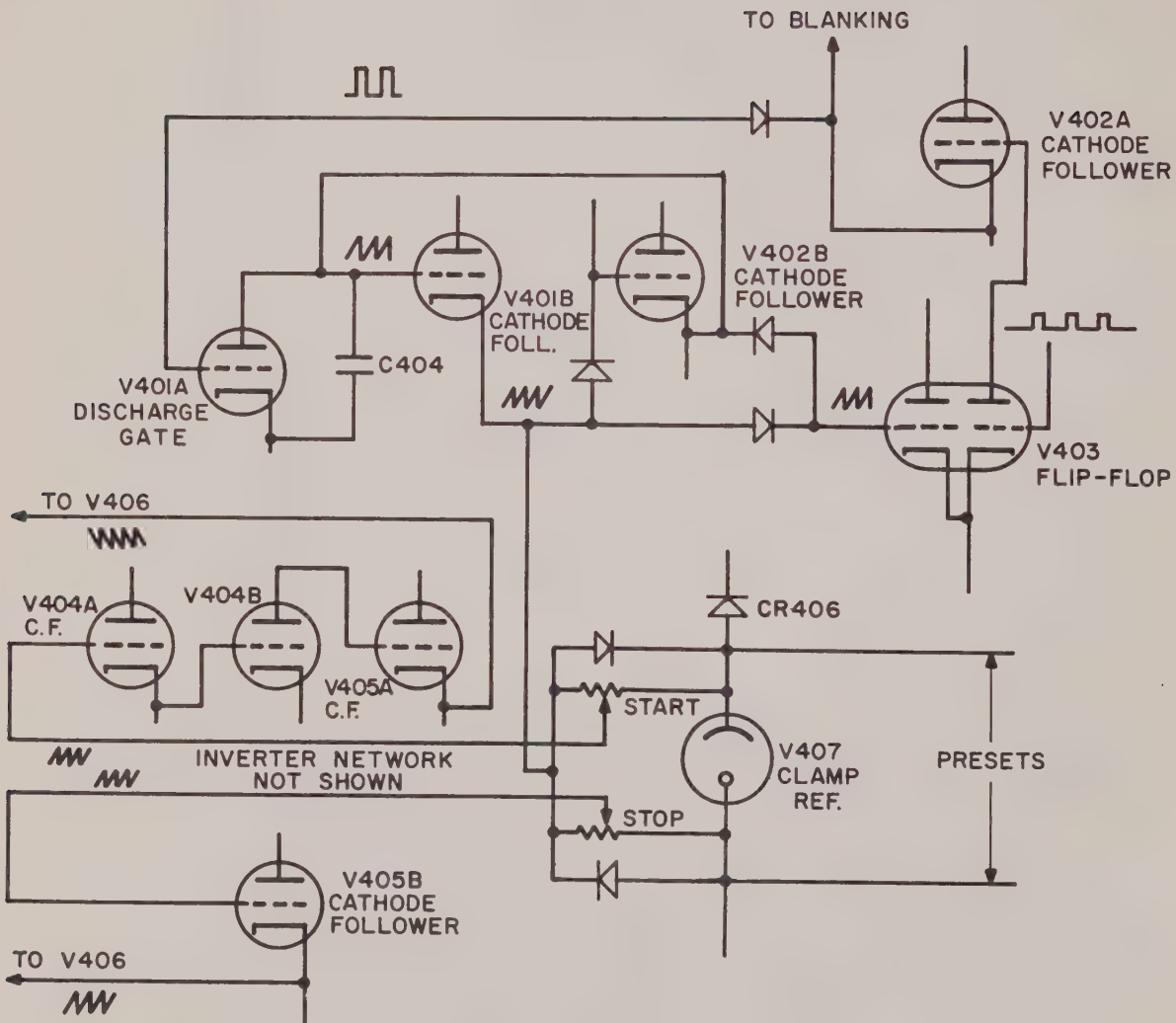


Fig. 1-5-1 The Sweep Generator Circuit

Next, signals are combined in V 406 to provide a sawtooth which is proportional to the bandwidth of the output. The signal has previously been clamped and separated into a positive and negative going sawtooth...a pulse is available during retrace (and will be used in blanking the output) and a constant voltage sawtooth is available at the input to the clamping circuit. All these signals are used internally and some, the constant and proportional signal outputs, are brought to the front panel for connection to external equipment.

1-5-2 Marker Circuit (Ref: Fig. 1-5-2)

The sawtooth (ramp) signal is sent simultaneously to R 615, C 604, R 604, C 606, Push-Pull Amplifier, V 601A, and Marker #2 Push-Pull Amplifier, V 603A. (The parallel circuit of Marker #2 is identical to that of Marker #1 and will not be described further.) At the signal level which permits current flow through V 601, a voltage transition is generated and fed to the Second Push-Pull Amplifier, V 602. V 602 develops both a negative-going ramp and a positive-going ramp at its outputs. The two ramps, with the aid of blocking diodes, CR 601 and CR 602, provide a notch in their combined output. Since the output, together with the output of the second marker circuit, is fed to the marker amplifier, V 201B, and then through CR 701 to the leveler, the signal effectively diminishes the power output of the BWO at a particular frequency and "marks" the trace seen on a scope or recorder.

1-5-3 Leveler Circuit (Ref: Fig. 1-5-3)

Both Series 880 and 881 Sweepers include leveler circuits. In Series 881's, the leveler internally samples the BWO output in a directional coupler, detects the sampled signal and feeds dc back to the BWO grid to hold power output at the set level. In Series 880's, the sequence and circuits are the same...except that the directional coupler and detector are external to the sweeper chassis and not supplied by Paradynamics with the Sweeper.

In either case, the detector output is sent to a mixer which also receives signals from the markers, the level set control and a square wave signal. The square wave raises BWO grid bias above cutoff and permits an RF output. The level set determines the power level of the RF output...adjusted to dip at the proper frequency (by the marker inputs) and to hold the power setting at the level value (by comparing the power output sensed by the feedback loop at the detector).

The resultant signal is amplified in two stages, V 703 and V 702, used to set the power level of a 10 Mc/s Oscillator, V 701, and inductively coupled through a 10 Mc/s coil to the grid and cathode of the BWO.

NOTE: The BWO grid is never allowed to swing positive relative to the cathode.

1-5-4 The Shaper

The sawtooth generated in the 400 deck is extremely linear...within 1%...and is the

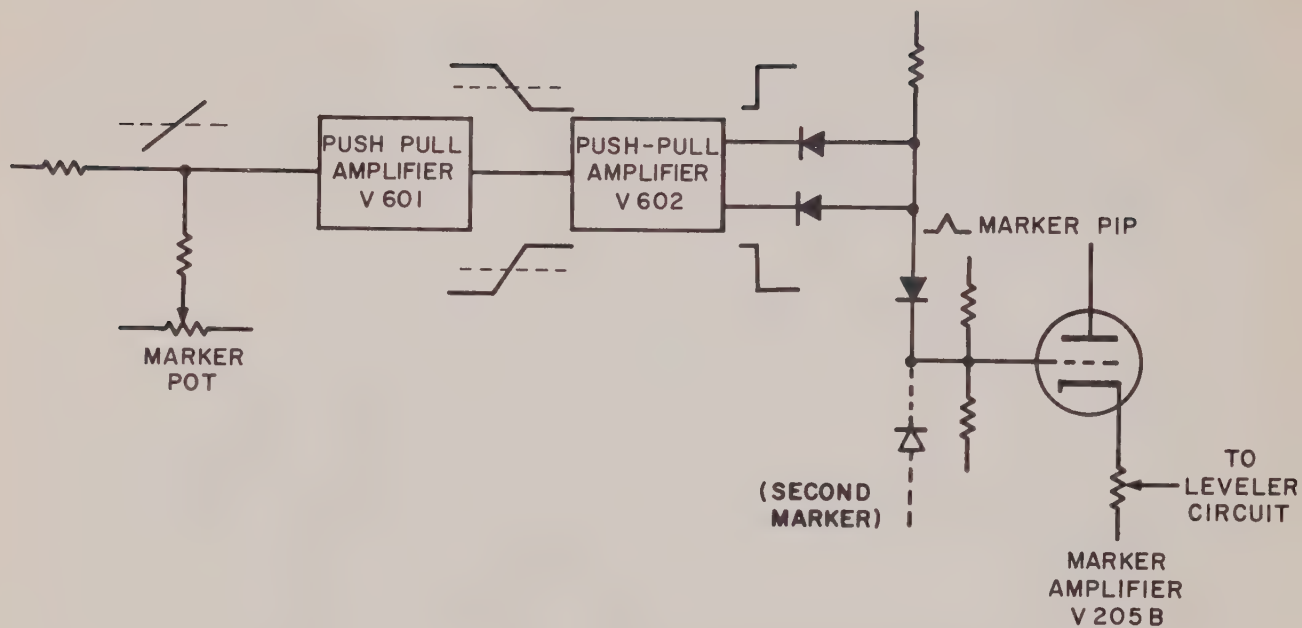


Figure 1-5-2. Marker Circuit

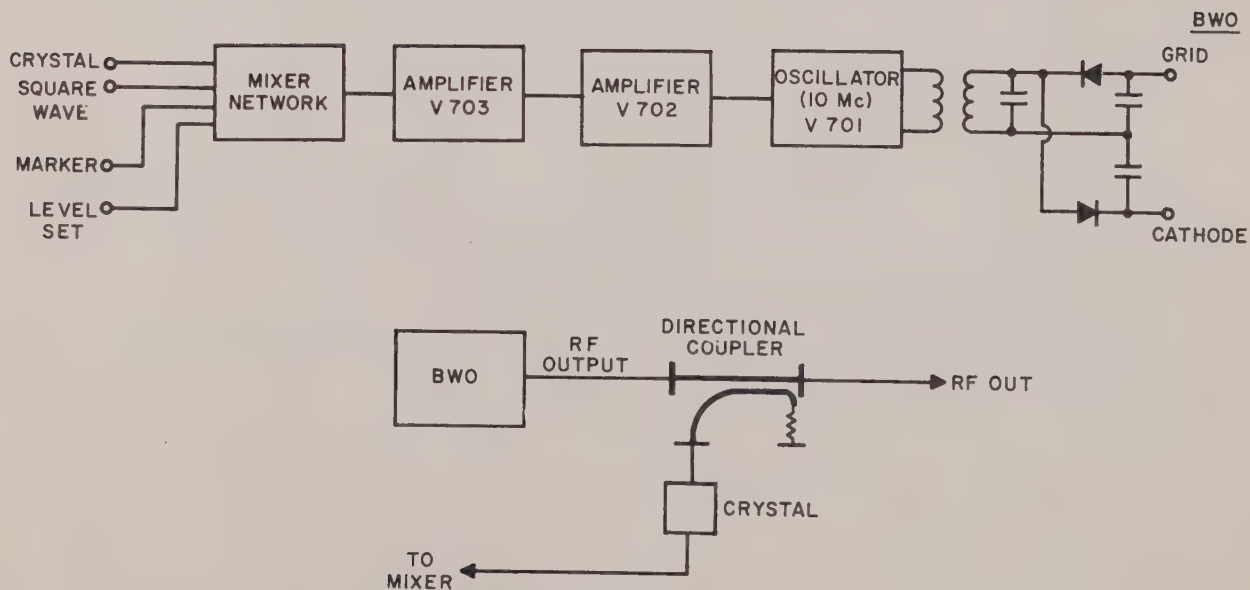


Figure 1-5-3. Leveler Circuit

basis of all frequency measurements within the Sweeper. The BWO characteristic output frequency, however, varies exponentially, not linearly, with helix voltage. For the BWO to sweep linearly, the sawtooth must be shaped to match the BWO output characteristic. The shaper, consisting of a series of diodes and fixed resistors, corrects the sawtooth to the waveform required to sweep the BWO linearly. Adjustment of the shaper is critical (if made without the proper test equipment) and is not considered part of the routine repair tasks. Do not attempt to adjust the shaper. Return Sweeper to Paradynamics for repair if necessary. See Section 7.

1-5-5 Helix Regulator

The characterized output of the Shaper is amplified to a sweeping negative high voltage in the Helix Regulator, deck 500. A difference amplifier, V 502, develops an error signal between its two inputs, a reference voltage and the output of a resistor mixing network...whose inputs are the shaper (through Cathode Follower, V 503) and the sweep voltages. This error signal, amplified through V 502, controls the grid voltage of Pass Tube Regulator, V 501, and thus its equivalent series resistance. The Pass Tube resistance, through negative feedback, varies the high voltage and reduces the error signal. Thus, as the sweep voltage increases (becomes more negative), the error signal tries to increase and causes the high voltage to become more positive, therefore, reducing the error.

1-5-6 Anode Regulator

The anode regulator (tied to high voltage) supplies the necessary regulated DC voltage to the anode of the BWO, see BWO data sheet at rear of manual for voltage level. This regulator consists of pass tube regulator V 101, control amplifier V 102B, and zener diode reference CR 121. Setting anode voltage potentiometer, R 119, adjusts anode voltage with respect to cathode.

1-5-7 Square Wave Modulator

The square wave modulator varies with BWO grid voltage to alternate the microwave output from full on to full off. The 1000 cps square wave generated by the multi-vibrator, V 605, can be switched on by S 806 and its frequency varied by (R 811) the front panel adjustment knob.

1-5-8 The Power Supplies

The power supplies consist of a low voltage and filament supply which is turned on immediately, and a high voltage supply which can be turned on only after a two-minute time delay.

The low voltage and filament supply provide the following:

- (a) 6.3 vac for the heaters of V 201, 202, 203, 204, 301, 303, 304, 305, 406, 501, 602, 604, 701 and 702.

- (b) Regulated +250 Volts, from bridge rectifier CR 115, 116, 117 and 118 Control Amplifier, V 305, Pass Tube Regulator, V 304, and reference Voltage Regulators, CR 301 and CR 302.
- (c) Regulated +150 volts, from CR 115, 116, 117, and 118 and C 108, together with Control Amplifier V 303, Pass Tube Regulator, V 304A, and reference Voltage Regulators, V 104 and V 105.
- (d) Regulated -300 volts, from CR 111, 112, 113 and 114, Control Amplifier V 302, Pass Tube Regulator V 301, reference Voltage Regulators, V 106 and 107. (Note: The plate of V 106 is grounded...or connected to the cathode of V 301. The cathode of V 106 is connected to the cathode of V 302A, referencing the V 302A cathode to the cathode of V 301. The cathode of V 302A is referenced to the cathode of V 302B, through V 107.)
- (e) Regulated -150 volts, again from CR 111, 112, 113 and 114, referenced to Voltage Regulator V 103 and the -300 volt supply.
- (f) Series Filament Voltage from the -300 volt supply and the -100 volt supply, filtered in C 107. This regulated filament supply is referenced to CR 201 and uses Pass Tube Regulators, V 203 and V 204 (in parallel) and Control Amplifier, V 202. The supply applies voltage to the series string of V 302, 404, 402, 401, 403, 405, 502, 503, 605, 603, 601 and 703. The voltage can be adjusted by potentiometer, R 207.
- (g) Filtered 6.3 vdc for V 101, V 102 and the BWO is provided by CR 109, 110, 131, C 106, R 105, R 106 and C 105. The voltage is slightly adjustable using R 106.

WARNING: ADJUST R 106 IN THE "STANDBY" POSITION ONLY.

1-5-9 Line Sync and Marker Cathode Follower

V 201, on the 200 deck, provides two functions not described elsewhere. V 201A is the Sync Trigger which, together with zener diode CR 202, generates a square wave and synchronizes the sweep to line frequency in "SYNC". Sharing the same tube envelope, V 201B is the output cathode follower which combines the two marker circuit outputs as the input signal to its grid. Together with Potentiometer, R 809, Marker Cathode Follower, V 201B, sends the marker setting information to the leveler (mixer) circuit.

PRELIMINARY

SECTION 2

OPERATING INSTRUCTIONS

2-1 General

This section describes normal operating procedures for Series 880 and 881 Sweepers. Operation is completely controlled from the front panel, although one adjustment is possible from the back panel. It is assumed that the operator knows how to set the Sweeper into the test program as discussed in Paragraph 1-1 and is ready to operate the Sweeper. By following each sequence in the operation, all the front panel controls will be described and their functions explained. In addition, a tabulation of front panel devices, included at the end of this section, lists the device and its functions in detail.

2-2 Operating the Sweeper (Ref: Fig. 2-1)

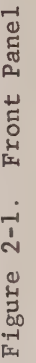
2-2-1 Turning the Sweeper On

With the power cord plugged into a polarized (grounded) outlet (described in Section 3, Installation), the Sweeper is ready to be turned on. To turn the Sweeper ON, flip the OFF-STANDBY-ON switch to "STANDBY". In this switch position, a time delay relay is immediately energized and withholds application of anode voltage and high voltage for 120 seconds. After the delay period, flip switch to "ON". The red High Voltage ON lamp will light, indicating the Sweeper is generating RF energy. In addition, although not particularly noticeable, the chemical Elapsed Time Indicator has been connected in parallel to the BWO heater and has been logging time of operation from the instant the OFF-STANDBY-ON switch was placed in "STANDBY". To remove RF energy, place switch in "STANDBY".

NOTE: In setting the Sweeper, the SWEEP MODE Selector Switch on the front panel must not be in "SYNC".

2-2-2 Setting the Frequency Band of the Sweep

Sweep band can be set from either of two front panel controls or from an external source. For individual, non-repetitive testing, the best method of setting sweep band is with the START-CW- Δ F control and the STOP control. With the Series 880 (or 881) Sweeper in "STANDBY" (high voltage is not required for setting the sweep band), rotate the START-CW- Δ F knob to the desired initial frequency of the sweep. The frequency can be read directly on the Slide Rule FREQUENCY DIAL situated across the top of the Front Panel. Similarly, the final frequency of the sweep can be selected by adjusting the STOP potentiometer...which has its own indicator on the same Slide



Rule FREQUENCY DIAL. As a point of interest, the Sweeper can be made to sweep down in frequency by adjusting the START-CW- ΔF control to a higher frequency setting than the STOP control setting.

For repetitive testing over one or more narrow bands within the available frequency range, Series 880 Sweepers offer convenient, easy-to-use control capability. If the bandwidth of the repetitive sweep is less than 10% of the range of the Series 880 Sweeper, the entire sweep can be preset into the Sweeper and repeated at will. If the band is greater than 10%, the center frequency can still be preset and, using the START-CW- ΔF control and the STOP control, this sweep can also be programmed into the Sweeper. In addition, Series 880 (and 881) Sweepers have the capacity for presetting F I V E such programmed sweeps!

To preset and preprogram a sweep, place the SWEEP MODE Selector in "CW PRESET". In this position, any of the five screwdriver-adjustment potentiometers can determine the center frequency of the sweep to be programmed. With the CW/ ΔF PRESET Selector Switch, select one of the five (A, B, C, D or E) positions and, with a screwdriver, adjust to the desired center frequency. This can be repeated for all five potentiometers. After setting the center frequency, rotate the SWEEP MODE Selector to " ΔF PRESET" and the SWEEP RATE Selector to "10-100", the fastest sweep setting. The ΔF WIDTH Control, the central potentiometer knob of the CW/ ΔF PRESET Control, can be rotated to select the sweep band width...up to $\pm 5\%$, equally spaced around the preset center frequency. The center frequency is easily preset, and the sweep band is readily adjusted for each change in bandwidth.

In all the above sweep operations, the band will be linearly swept...frequency changes linearly with time. In addition, a continuous band will be swept, either once or repetitively, as selected by the SWEEP MODE Control. For repetitive sweeping, or for automatically sweeping several small bands within the capability of the Sweeper, an external signal can be determined and introduced into the Sweeper, describing linear, nonlinear, step function and any other desired sweep program. For this type of external-source program, the SWEEP MODE Selector Switch is placed in "EXTERNAL" and the desired program fed into the EXTERNAL SWEEP Connector. For use of the external sweeping facility of the Series 880 Sweeper, a graph of voltage input vs frequency should be made (and checked before each test) for the specific instrument to be used. The External Sweep circuit provides a linear frequency vs voltage input characteristic.

2-2-3 CW operation

The Sweeper can be employed as a CW Signal Source in either of two positions of the SWEEP MODE Selector Switch, "CW PRESET" and "CW". The output frequency in "CW PRESET" is determined by the setting of the CW/ ΔF PRESET screwdriver adjustment... and selected by the CW/ ΔF PRESET Selector Switch. In the "CW" position of the SWEEP MODE Selector Switch, the START/CW- ΔF Potentiometer setting determines the CW output of the Sweeper.

NOTE: A constant voltage input to the external connector, EXTERNAL SWEEP, also represents a CW operation and may be used as such in part of a program. However, the

external operation of the sweeper in a CW mode represents one of many possible, but trivial, operational modes which will not be discussed further.

2-2-4 AM Modulation of Sweep or CW

The AM CONTROL Selector Switch has four positions, "EXTERNAL PULSE", "OFF", "SQUARE WAVE", and "EXTERNAL". In "OFF", no AM is added to the RF output of the Sweeper. In "SQUARE WAVE", the RF output is alternated between zero and full RF at an adjustable rate from 800 to 1200 cycles per second. In addition, Series 800 Sweepers include a SYMMETRY ADJUST which allows the ratio of time of maximum RF output to zero output to be varied from 2:3 to 3:2 (or 40 to 60% on). In "EXTERNAL", an external AM can be impressed on the RF output. The AM is brought into the Sweeper through the EXTERNAL AM Connector. In "EXTERNAL PULSE", the RF output is alternated between zero and full power output for the duration of pulse signal introduced into the EXTERNAL PULSE Connector.

2-2-5 Power Leveling

Series 880 Sweepers include internal leveling circuits which hold the power output within a db for the total frequency range of the Sweeper or within ± 0.15 db over the ΔF range (10% of the total range).

The ALC Selector has three positions, "OFF", "INT", and "EXTERNAL". In "OFF", the overall power output variation can be as much as 6 db. In the usual leveled operation of the Sweeper, a directional coupler located in the RF output samples the RF, sends it to a crystal detector, where it is rectified compared to a level setting and the error is fed back to the grid of the BWO...thereby holding power to the requisite level. The basic differentiation between Paradyamics Series 880 and Series 881 Sweepers is the location of the directional coupler and the detector. In Series 881 Sweepers, the directional coupler and detector are internal components; in Series 880 Sweepers, they are external (and not supplied with the unit). Thus, for Model 881 Sweepers, the ALC Selector is placed in "INT" for leveled operation. For Model 880 Sweepers, the user provides the RF components and injects the derived sample into the "EXT" jack and placed the ALC Selector in "EXT".

2-2-6 Connecting the Sweeper into the Circuit

With the major adjustments already made, the Sweeper is ready to be connected into the test circuit. The measurement parameter is usually fed into a scope (CRO) or a recorder as the "Y" coordinate and the frequency as the "X" coordinate. The measurement parameter, obtained from other test equipment, is then either indicated or recorded as a function of frequency. The frequency base, however, is fed to the CRO or recorder from the Sweeper. To accomodate the slower speeds of recorders and the desirability of matching the entire sweep band of the Sweeper to the graph of the recorder, use a slow sweeprate and the proportional sweep output with the recorder. For scope indication, a faster sweeprate and constant output can be employed.

For setting sweeprate, use the SWEEP Selector in any of its five positions: "0.01-0.1", "0.1-1.0", "1.0-10", "10-100", and "SYNC". The Selector determines the available band of sweeprates...setting "0.01-0.1" permits sweeps of 0.01 to 0.1 cycles per second...and the potentiometer in the center of the Selector fixes the actual sweeprate. (For example, a sweeprate of 0.08 cps is achieved by setting the Selector to "0.01-0.1" and the potentiometer to that value which gives 0.08 cps.) For synchronizing the sweep to the power line, use the "SYNC" position of the SWEEP Selector.

After selecting the sweeprate to match the scope or recorder, connect the scope or recorder to the appropriate SWEEP OUTPUT Connector, either PROPORTIONAL or CONSTANT. (As mentioned previously, scopes will normally be connected to the CONSTANT output connector and recorders to the PROPORTIONAL output connector.)

To cross reference the Sweeper to the scope, two markers have been included in Series 880 Sweepers. Each marker operates independently of the other, each has its own counter type numerical indicator. Each marker causes the sweep to mark at the value of frequency shown on its indicator.

Connect the RF output of the Sweeper to the test set-up and advance the OFF-STANDBY-ON Switch to "ON". At this time, the HV ON Lamp should light. (If the Sweeper was turned "OFF" at any time, two minutes warm-up is required before the Sweeper applies HV to the BWO.)

2-2-7 Selecting the Sweep Mode

When installing the Sweeper into a test program, several choices of Sweep Mode are available to the operator. He may (and should) sweep once to test the entire set-up before making meaningful tests; he may hold a CW output from the Sweeper to check the external circuits; he may require several retraces across a scope face and therefore want the Sweeper to sweep recurrently; or he may decide to use any of the preset sweeps or external programming available to him. All these sweep modes are available within the capability of the Series 880 Sweeper. The SWEEP MODE Selector permits an operator to select: "SINGLE", "CW PRESET", "CW", "RECURRENT", "MANUAL", " Δ F PRESET", " Δ F", or "EXTERNAL" sweep modes.

In "SINGLE", the Sweeper will sweep between the settings of the START-CW- Δ F and STOP Controls once, blank itself and hold at the setting of the START-CW- Δ F Control...when the SWEEP TRIGGER Pushbutton (alongside the SWEEP MODE Selector Switch) is pressed. If pressed a second time, the RF output will again sweep between the settings of the two controls. For electronic triggering, a trigger may be injected into the signal jack (located directly below the pushbutton).

In "CW", Sweeper output will be CW at the frequency indicated by the pointer which follows the START-CW- Δ F Control. (The Sweeper does not blank in this position unless a deliberate blanking signal is fed into the EXTERNAL AM CONNECTOR.)

In "CW PRESET", Sweeper output will be CW at the frequency selected by one of the five Preset Center Frequency Pots above the PRESET Selector.

Series 880 & 881 Swept Signal Source

In "RECURRENT", the Sweeper will sweep and continue to sweep between the settings of the START-CW- Δ F and STOP Controls...and blank during retrace. This recurrent sweep starts immediately as the SWEEP MODE Selector is placed in "RECURRENT" and continues until the Selector is rotated to another position.

In "MANUAL", the Sweeper will have an RF output within the band formed by the START-CW- Δ F and the STOP Controls, and determined by the MANUAL SWEEP Potentiometer. The MANUAL SWEEP Pot allows an operator to manually sweep or operate CW within the settings of the two control potentiometers. In this manner, fine, slow sweeping and rapid scanning are both possible...usually preliminary to testing, or to locate a very narrow excursion of a parameter from the smooth, swept curve which was expected. Running a slow, manual sweep before testing can quickly locate frequencies of interest in the parameter being measured.

In " Δ F PRESET", the Sweeper will provide an RF output continuously sweeping from low to high frequency across the frequency band selected by the Δ F WIDTH Control and with a center frequency determined by the Δ F PRESET Selector position.

In " Δ F", the Sweeper will provide an RF output continuously sweeping approximately from +5% to -5% about the center frequency as selected by the START-CW- Δ F Control.

In "EXTERNAL", the Sweeper will follow any program scheduled into it from the EXTERNAL SWEEP Connector. In addition to the sweep, the external programming must also provide for blanking, if desired.

2-2-8 Other Features Available from Series 880 Sweepers

Series 880 Sweepers also have a "PEN LIFT" connection for use with a recorder. This is an output jack which provides a voltage signal during fly-back or retrace for lifting the pen off the chart of a recorder and thereby preserving the sweep record without danger of overtracing with a fast, erratic inkline. The feature is available for the two slowest speed ranges. No blanking occurs in these ranges.

Series 880 Sweepers also include two five-way binding posts which parallel the timing capacitor of the sweeper...thereby permitting addition of external capacitance to slow the sweep rate down to hours, if desired.

2-3 Front Panel Devices

2-3-1 OFF-STANDBY-ON Selector

This is the power line selector which applies power to the Sweeper, or removes power at the completion of a test. In "OFF", power is removed from the Sweeper. In "STANDBY", all low voltage circuits are connected to power...including the BWO heater circuit to warm the BWO prior to applying anode, helix and collector voltages. In "ON", a 2 minute time delay relay, brought in during "STANDBY", must first time out, then, all voltages are applied to the Sweeper.

2-3-2 START-CW- Δ F Control

The START-CW- Δ F Control is a potentiometer which can be used to determine the frequency at which a sweep will start or the frequency of CW output of the Sweeper. With the SWEEP MODE Selector in "SINGLE" or "RECURRENT", the START-CW- Δ F Control determines the frequency at which the sweep starts. With the SWEEP MODE Selector in "MANUAL", the START-CW- Δ F Control acts as the lower frequency limit for the Manual Sweep. In " Δ F", the START-CW- Δ F Control determines the center frequency of a sweep of approximately 10% bandwidth.

2-3-3 Slide Rule FREQUENCY DIAL

The Slide Rule FREQUENCY DIAL is calibrated directly in frequency of RF output. Two sliding indicators follow the START-CW- Δ F Control and the STOP Control.

2-3-4 MARKER 1 Control

MARKER 1 Control is a potentiometer which adjusts the balance point of a marker circuit to place a small dip in the RF power at the set frequency. The set frequency of MARKER 1 Control is indicated on the digital MARKER INDICATOR to its right.

2-3-5 MARKER INDICATOR (#1)

The MARKER INDICATOR is a counter-type digital frequency indicator, directly linked (mechanically) to the MARKER 1 Control.

2-3-6 MARKER AMPLITUDE Control

The MARKER AMPLITUDE Control is a potentiometer which determines the height of the marker pips, variable from 0 to 100% of full scale output. The one control fixes the pip amplitude for both markers.

2-3-7 HIGH VOLTAGE ON Lamp

The HV ON Lamp is lit whenever high voltage is generated within the Sweeper. If the Sweeper has been in either "ON" or "STANDBY" for more than 2 minutes, the HV ON Lamp will light when the OFF-STANDBY-ON Selector is in "ON".

2-3-8 MANUAL SWEEP Control

The MANUAL SWEEP Control is a potentiometer which permits an operator to adjust the RF output frequency to any value between the limits set by the START-CW- Δ F Control

and the STOP Control. By rotating the control slowly, the operator can slowly sweep the output across the band.

2-3-9 MARKER INDICATOR (#2)

The MARKER INDICATOR is a counter-type digital frequency indicator, directly linked (mechanically) to the MARKER 2 Control.

2-3-10 MARKER 2 Control

MARKER 2 Control, a potentiometer, adjusts the balance point of a circuit which places a marker at the set frequency. The set frequency of MARKER 2 Control is indicated on the digital MARKER INDICATOR to its left.

2-3-11 STOP Control

The STOP Control is a potentiometer which can be used to determine the frequency at which a sweep will stop. With the SWEEP MODE Selector in "SINGLE" or "RECURRENT", the STOP Control determines the frequency at which the sweep stops. With the SWEEP MODE Selector in "MANUAL", the STOP Control acts as the upper frequency limit of the Manual Sweep.

2-3-12 RF OUTPUT Connector

The RF OUTPUT Connector either brings power directly from the BWO helix coupling (in Paradyamics Series 880 Sweepers) or from the main line of a directional coupler (in Paradyamics Series 881 Sweepers) to be connected to the external circuitry.

2-3-13 EXTERNAL ALC Connector (External Power Control Connection)

The EXTERNAL ALC Connector brings a voltage signal to the Sweeper to control its Automatic Leveling Circuit (ALC) in the "EXTERNAL" position of the ALC Selector. The signal fed into the EXTERNAL POWER CONTROL Connector controls the grid voltage of the BWO (which is never permitted to go positive).

2-3-14 ALC Selector and Control (Power Adjust)

The ALC Selector is a three-position switch with stations marked: "OFF", "INTERNAL", and "EXT", in "OFF", no Automatic Level Control is applied to the power output of the Sweeper and the variation in power across the swept band may be as great as 6 db from minimum power output to maximum. The power variation in "OFF" corresponds to the BWO power output variation across the band with a fixed bias applied to its grid.

In "INTERNAL", the power output variation is held to approximately 1 db across the entire band of the Sweeper, and considerably closer for narrow bandwidth sweeping. In the "INTERNAL" position, the central knob of the Selector determines the power output level to which the BWO will be restrained. To assure correct leveling, the Sweeper should never be operated in a leveled mode at power outputs greater than the minimum guaranteed power output of the BWO.

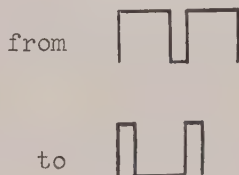
In the third position of the Selector, "EXT", a signal fed into the EXTERNAL ALC Connector is applied to the grid of the BWO and the power output is a function of the shape of the external signal. Leveling action similar to that afforded in "INT" is available with the exception that the RF sample is supplied by the user and can be derived from any point in the test set-up.

2-3-15 EXTERNAL AM Connector

AM modulating signals can be brought into the Sweeper through the EXTERNAL AM Connector with the AM Control in its "EXT" position. The AM signal may square- or sine-wave modulate the RF output, blank the output or apply any desired modulation superimposed on the RF output.

2-3-16 AM Selector and Control

The AM Selector is a four-position switch with stations marked: "EXT PULSE", "OFF", "  ", and "EXT". In "EXT PULSE", the RF output remains blanked until a signal arrives at the EXTERNAL PULSE Connector and, upon the arrival of the pulse, the Sweeper is no longer blanked and the Sweeper output is controlled by the front panel device settings. This operation continues for the duration of the pulse. In "OFF", no audio modulation is applied to the RF output. In "  ", (signifying square wave), the output is alternated between full RF and zero RF at approximately 1000 cps. In addition, as described in Paragraph 2-3-18, an AM SYMMETRY ADJUST Control permits the square wave to take any non-symmetric (asymmetric) shape from 40% full RF to 60% zero RF, to 60% full RF to 40% zero RF. Pictorially,



In the "EXT" Position, the signal fed into the EXTERNAL AM Connector controls the AM modulation of the RF output.

2-3-17 EXTERNAL PULSE Connector

The EXTERNAL PULSE Connector applies a signal to the grid of the BWO to un-blank it for the duration of the pulse. The required signal voltage may range to 100 volts positive.

2-3-18 SYMMETRY ADJUST Control

The SQUARE WAVE SYMMETRY ADJUST Control is a potentiometer which varies the ratio of RF output time to zero output time from 3:2 to 2:3.

For detection systems in which the detected signal is severely attenuated or possible loss of weak signal may occur, the RF to zero output ratio should be as great as possible to permit the largest amount of signal to be detected.

2-3-19 EXTERNAL SWEEP Connector

Operating in conjunction with the "EXT" position of the SWEEP MODE Selector, the EXTERNAL SWEEP Connector allows an external sweep program to be scheduled into the Sweeper. In the "EXT" position, the internally-generated sawtooth is withheld from the shaper and the external signal amplified and fed to the shaper in its place.

2-3-20 SWEEP MODE Selector

The SWEEP MODE Selector is an eight-position switch with stations marked: "SINGLE", "CW", "CW PRESET", "RECURRENT", "MANUAL", " Δ F PRESET", " Δ F", and "EXT".

In "SINGLE", the Sweeper will hold RF output at the frequency determined by the START-CW- Δ F Control until the SINGLE SWEEP Pushbutton is pressed. Then, the Sweeper will apply an RF output, modulated as determined by the AM Control, at a rate determined by the SWEEP Control, sweeping to the setting of the STOP Control. As the sweep arrives at the frequency value set by the STOP Control, the Sweeper will blank or apply a PEN LIFT signal...and return (fly back) to the frequency setting of the START-CW- Δ F Control. The Sweeper will remain blanked until the SINGLE SWEEP Pushbutton is again pressed. Applying a trigger pulse to the External Input Trigger jack electronically triggers the Sweeper.

In "CW", the Sweeper will have a CW RF output as determined by the START-CW- Δ F Control frequency setting. The CW may be AM modulated, see Paragraph 2-3-16.

In "CW PRESET", the Sweeper will have a CW RF output as determined by the Δ F PRESET Center Frequency Control Potentiometer selected by the CW/ Δ F PRESET Selector. The CW output may be AM modulated, see Paragraph 2-3-16.

In "RECURRENT", the Sweeper output starts at the frequency setting of the START-CW- Δ F Control, sweeps to the setting of the STOP Control, retraces (with RF output blanked) to the frequency setting of the START-CW- Δ F Control, and again sweeps to

the frequency setting of the STOP Control. This process continues until the SWEEP MODE Selector is rotated to another position.

In "MANUAL", the output frequency of the Sweeper is controlled by the MANUAL SWEEP Control, described in Paragraph 2-3-8.

In " Δ F PRESET", the output of the Sweeper sweeps about the center frequency set on the Δ F PRESET Center Frequency Control Potentiometer selected by the Δ F PRESET Selector. The bandwidth of the sweep is determined by the setting of the Δ F WIDTH Control (the potentiometer whose knob is coaxial with the Δ F PRESET Selector).

In " Δ F", the Sweeper output sweeps through a 10% (approx) bandwidth centered about the frequency set on the START-CW- Δ F Control.

In "EXT", the Sweeper output is completely controlled by the signal input to the EXTERNAL SWEEP Connector. Note that blanking signals must also be programmed into the schedule to cut the RF power output to zero during any retrace cycles. In addition, the AM Selector and ALC Selector are active and will continue to function normally.

2-3-21 EXT TRIGGER INPUT Connector

To synchronize the Sweeper with another piece of test equipment, it may be desirable to trigger both units from a single pulse. The Series 880 and 881 Sweepers permit simultaneous triggering by providing an EXT TRIGGER INPUT Connector to initiate a sweep when SWEEP MODE Switch is in "SINGLE" position.

2-3-22 SINGLE SWEEP Pushbutton

In the "SINGLE" position of the SWEEP MODE Selector, the SINGLE SWEEP Pushbutton initiates the sweep, or externally applied pulses (via external input Trigger jack) start the sweep.

2-3-23 CW/ Δ F PRESET Selector and Δ F WIDTH Control

Series 880 and 881 Sweepers include five presettable potentiometers, lettered "A", "B", "C", "D", and "E", which represent five preset center frequencies to be employed in the various programs using the Sweeper. The position of the CW/ Δ F PRESET Selector, a five station switch, chooses the potentiometer to be incorporated in the program...hence selects the center frequency to be incorporated into the program. Each of the five PRESETS may be set by adjusting the screwdriver-positionable variable contacts. To set a PRESET, rotate the CW/ Δ F PRESET Selector to the corresponding "PRESET" position, rotate the SWEEP MODE Selector to "CW PRESET", and read the preset frequency on an external wavemeter.

After each of the PRESET potentiometers has been set, any can be selected and employed as either the CW frequency or the center frequency of a Δ F sweep. In

sweeping, the width of the sweep may be adjusted by the ΔF WIDTH Control, the center knob of the CW/ ΔF PRESET Selector and ΔF WIDTH Control Assembly. The bandwidth is restricted to approximately $\pm 5\%$ of the maximum output frequency range of the Sweeper.

2-3-24 SWEEP Selector and Control

The SWEEP Selector is a five-position switch used to select the sweep rate. Its ranges are: "0.01-0.1", "0.1-1.0", "1.0-10", "10-100", and "SYNC". The numbered settings have units of sweeps per second. In any one position of the Selector, the actual sweep rate is determined by the FREQ ADJ Control, a potentiometer with a knob in the center of the SWEEP Selector (annular) knob. By rotating the control, any sweep rate within the band selected by the SWEEP Selector can be obtained. In the "SYNC" position of the Selector, the sweep is in synchronism with the power line frequency and will be phase locked with other test equipment similarly sync-ed. The "SYNC" position should never be used when adjusting and setting the Sweeper. In fact, the "SYNC" position should only be employed for narrowband tests...occupying less than 5% of the total band capacity of the Sweeper.

2-3-25 (CONSTANT) SWEEP OUTPUT Connector

This connector provides the sawtooth sweep voltage which indicates the instantaneous RF output frequency of the Sweeper. Without regard to bandwidth of the sweep, the signal available at this connector will always sweep from zero volts to a given maximum voltage, approximately 25 volts. This constant output voltage is ideal for scope presentation of a parameter as a function of frequency. The entire horizontal movement of the scope trace is, therefore, independent of the bandwidth of the sweep.

2-3-26 (PROPORTIONAL) SWEEP OUTPUT Connector

This connector provides the sawtooth voltage which linearly indicates the RF output frequency of the Sweeper. The maximum available voltage, approximately 25 volts, is representative of the full band of the Sweeper. A proportionately decreased...and linearly displaced...sawtooth output is available for lesser bandwidths. This proportional output voltage is ideal for recorder presentation of a parameter as a function of frequency. The entire width of (reticle) graph represents the entire band capability of the Sweeper...and any smaller swept band will be presented over the portion of the graph which correctly represents its bandwidth and frequency coordinate.

2-4 BACK PANEL DEVICES (Ref: Fig. 2-2)

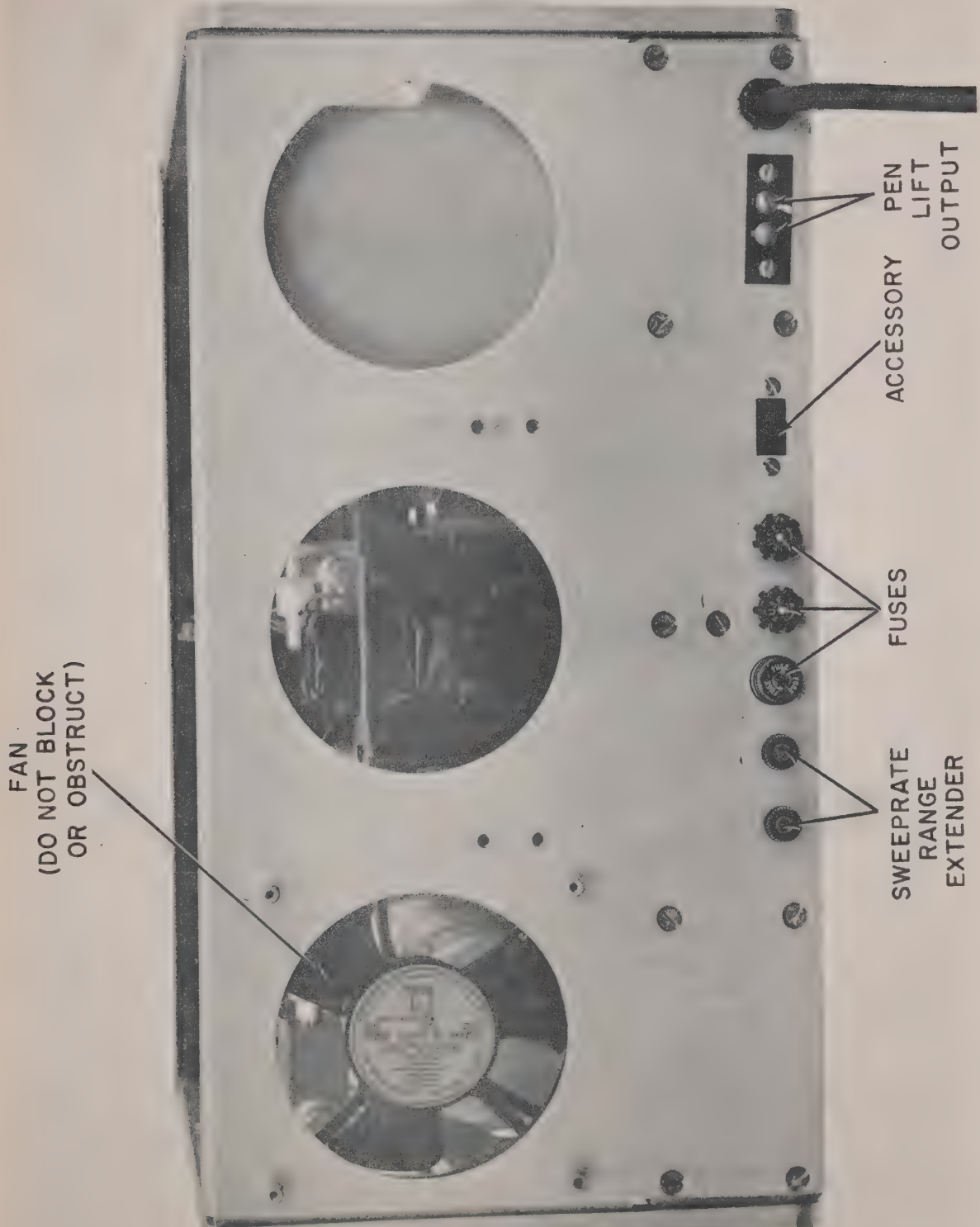


Figure 2-2. Rear Panel

2-4-1 SWEEP RATE RANGE EXTENDER Binding Posts

Two five-way binding posts, called the SWEEP RATE RANGE EXTENDER, parallel the largest timing capacitor of the Sweeper. Capacitance, added across the posts, can reduce the sweep rate to any reasonable slow speed. Approximately 20 seconds are added to the sweep rate for each additional microfarad of capacitance. Do not parallel electrolytic capacitors or any polarized capacitor to the SWEEP RATE RANGE EXTENDER.

2-4-2 PEN LIFT Connector

At sweep speeds normally used for recording, i.e., less than 1.0 cps, the Sweeper provides an output at the PEN LIFT Connector which will automatically lift the pen of a recorder during the retrace period between successive sweeps. At the end of the retrace period, the signal is removed and the recorder's pen again contacts the recorder chart.

2-4-3 FUSES, F 101, F 102 and F 103

Three protective fuses are located on the back panel in bayonet-type fuse-holders. Before any attempt is made to remove these fuses, the Sweeper line cord should be removed from the outlet.

FUSE F 101 protects the fan and sweeper but excludes the convenience (ACCESSORY) outlet, switch and line cord. The rating of F 101 is 5 amperes and should never be replaced by any fuse capable of passing more than 5 amps.

FUSE F 102 protects the high voltage components of the Sweeper and excludes such components as the Fan, Time Delay Relay, Relay and low voltage Transformer which remain protected by F 101. F 102 is rated at 2 amps and should never be replaced with a fuse of greater current carrying capacity.

FUSE F 103 protects the anode circuit from excessive current drain. The rating of this critical fuse is 30 milliamps. Under no circumstances should a fuse of higher or lower rating be installed in the F 103 fuse holder.

2-4-4 ACCESSORY outlet

A convenience outlet has been provided on the back panel. It is switched by the "OFF-STANDBY-ON" Switch and provides 110 vac (nominal) at its terminals. For 220 vac Sweepers, the Accessory Outlet supplies 220 vac.

SECTION 3
INSTALLATION

3-1 General

The Series 880 and 881 Sweepers have been designed as rack or bench mounted pieces of test equipment and, as such, require no formal installation. Upon receipt of the unit from the factory...and in accordance with standard industrial procedure...the carton should be inspected for damage during shipment, for damage as the result of environment (water spots, humidity, fungus, etc.) and a report of any adverse findings made to Paradyamics, Inc. Service Dept. Standard "Request for Maintenance" forms are described in Paragraph 7-2 and included at the back of the manual.

NOTE: Do not install any magnetically sensitive equipment near this Sweeper. The permanent magnet of the BWO has a strong field which, although shielded, may affect meters, instruments and other devices which rely on low-level magnetic ambients. Remove wrist watches before handling BWO.

3-2 Services Required

Paradyamics Series 880 and 881 Sweepers plug into standard, 3-prong, 110 vac, 60 cycle outlets. (Note: 220 volt units are available.) The Sweeper contains its own cooling fan. Passage of air to and from that fan should not be restricted. The usual precautions concerning shock and vibration must be taken and the Sweeper should be located in the fairly clean, dry and vibration-free type of surrounding normally provided for test equipment.

NOTE: The Sweepers are rugged and will accept considerable abuse. However, one component, the BWO, represents more than half the cost of the Sweeper. Any damage to this tube will result in repair charges which seem out-of-line with the cost of the original Sweeper. Therefore, if at all possible, guard against damage to the BWO in particular. When locally shipping the unit, either ship the BWO separately, or use sufficient packing around the BWO to assure its safe arrival.

CAUTION: In operation, the Sweeper internally generates voltages which are harmful, possibly fatal, if touched. Observe caution during calibration and service.

The inputs to the Sweeper are:

- 1- Power: 110 vac, 60 cycles per second, 450 watts.
- 2- Air: Room air is sufficient. Do not block fan.

NOTE: For 220 vac operation, request complete instructions from:
Paradyamics, Inc., Huntington Station, New York.

3-3 Size

Model 880 and 881 are 8-3/4" high, 17½" wide (to fit standard racks) and 21½" deep. Brackets are supplied for fastening the Sweeper to a standard rack.

SECTION 4
MAINTENANCE

WARNING: USE EXTREME CAUTION IN SERVICING THIS INSTRUMENT. VARIOUS POINTS ARE AT HIGH VOLTAGES. FOR IDENTIFICATION, HIGH VOLTAGE LOCATIONS ARE REFERENCED WITH AN ASTERISK (*) THROUGHOUT SECTION 4 OF THIS MANUAL.

4-1 General

An understanding of the theory of operation, described in Paragraphs 1-4 and 1-5, will prove helpful in locating and correcting any defect which may occur. Refer to Paragraph 4-2 for troubleshooting procedures. Paragraph 1-3 describes the component numbering system.

4-1-1 Preventive Maintenance

Preventive maintenance consists only of the following:

- (1) Oil fan blower motor once every six months using SAE #10-30 oil. Clean intake air filter at the same time.
- (2) Test all receiving tubes periodically (6 month intervals).
- (3) Vacuum or blow accumulated dirt out of Sweeper periodically (6 month intervals).

4-1-2 Troubleshooting - Preliminary Checks

If trouble arises in the Sweeper, the following preliminary checks should be made. For checks 1 through 6, the OFF-STANDBY-ON Switch should be in "STANDBY". For check 7, the Switch should be in "ON".

First, test all tubes. Replace faulty or inoperative ones.

Second, check (and adjust, if necessary) all power supplies to assure proper source voltages throughout the chassis. Power supply checks are listed following this paragraph. For faults in a power supply, test capacitors and diodes for shorts or opens. Inspect resistors for melting or over-temperature operation. Replace all defective components.

1. Regulated Filament String

The voltage between pin 4, V 703 and pin 5, V 302, Figure 5-1, should be -144 volts DC. If not, voltage differential may be corrected by adjusting R 207, Fig. 4-2-1.

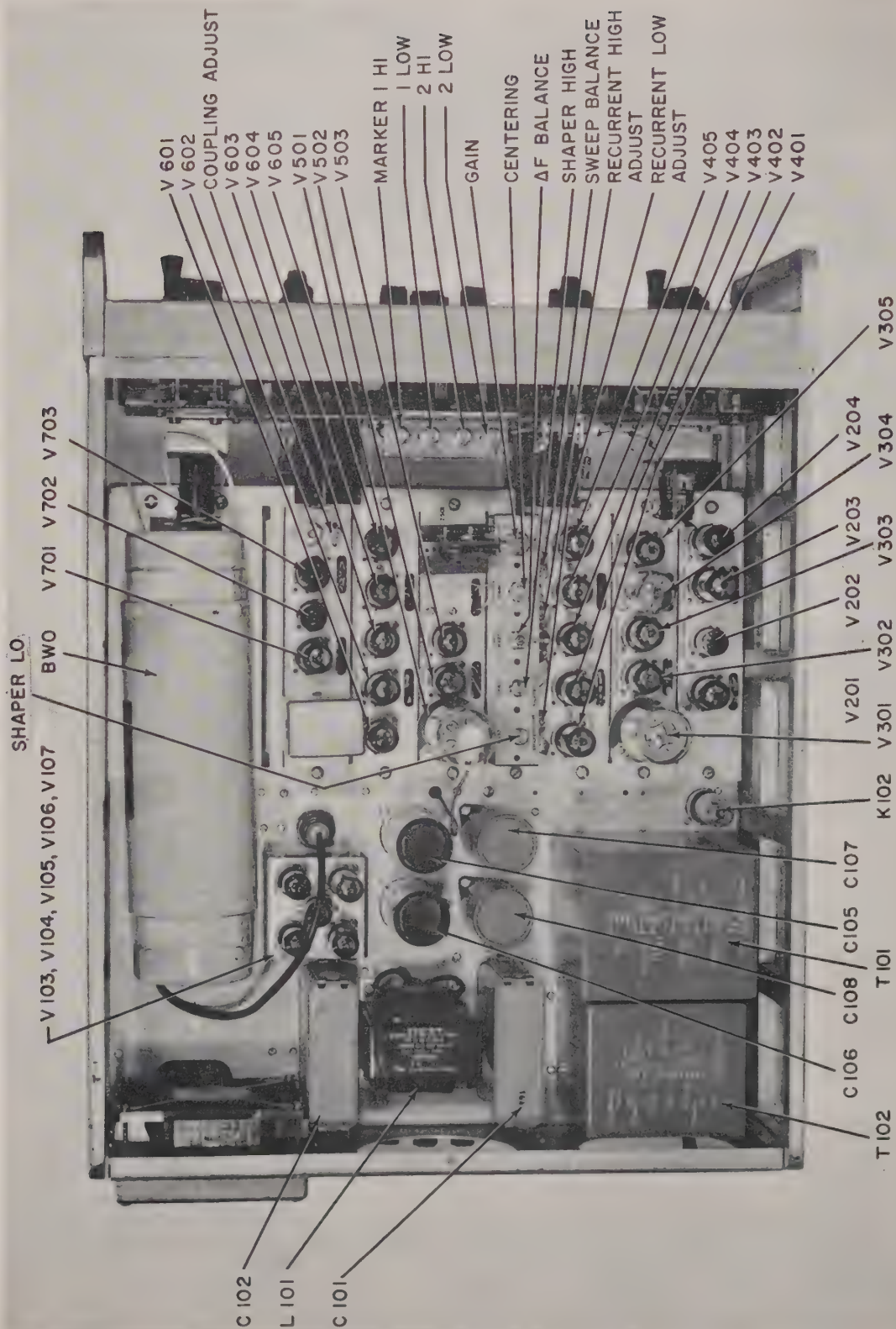


Figure 4-2. Top View of Chassis

2. -300 Volt Regulated Supply

The voltage between C 107 and ground should be -300 volts DC. Loss of the -300 volt supply is indicated by loss of sweep and output.

3. -150 Volt Supply

The voltage between pin 2, V 103 and ground should be -150 volts DC. Without -150 volts, the Sweeper will not be able to correctly present the sweep.

4. +150 Volt Supply

The voltage between pin 9, V 304 and ground should be +150 volts DC. Loss of this supply is accompanied by drift in the sweep presentation.

5. +250 Volt Supply

The voltage between pin 8, V 304 and ground should be +250 volts DC.

6. BWO Filament Supply (Sweeper must still be in "STANDBY".)

The voltage across pins 5 and 4 of V 101 must be +6.5 volts DC for proper operation. Adjust R 106 to this voltage. Both BWO and parallel tubes, V 101 and 102 must be installed while setting this voltage.

7. Helix Supply

The helix voltage (see BWO data sheet, "Delay Line Voltage") measured between pin 9* of V 102 (-HV) and ground should be variable when adjusting the "MANUAL" Control with the Sweeper in its "MANUAL" sweep mode. The voltage should conform to the Frequency-Voltage characteristic of the BWO...with frequency measured by a Frequency Meter in the Sweeper OUTPUT.

4-2 Troubleshooting

In general, a 20 K ohm/volt meter is sufficient for measuring all voltages except at points of very high input impedances such as grids or plates having high plate resistances. In these measurements, a VTVM with at least 10 megohms input impedance is suggested. For observing waveforms, an oscilloscope with 10 megohm input (X 10 Probe) is recommended.

Troubles obvious to any person servicing this Sweeper will not be listed. This includes blown fuses, burned-out tubes and pilot lights. After a first check, however, the Sweeper should be turned OFF and all fuses tested for continuity on a multi-meter which draws less than 2 milliamps. It is also assumed that, if a string of tubes is out, the serviceman will have no difficulty locating the "open" tube.

GENERAL GUIDE NOTE: In this Troubleshooting Section, unless otherwise specified, the word "check" shall mean that the tube pin voltages and compare them to those listed in Paragraph 4-4. When discrepancies exist, determine the cause of the discrepancy and correct it. Before proceeding, retest operation of the Sweeper to determine if correcting the discrepancy has corrected the Sweeper fault.

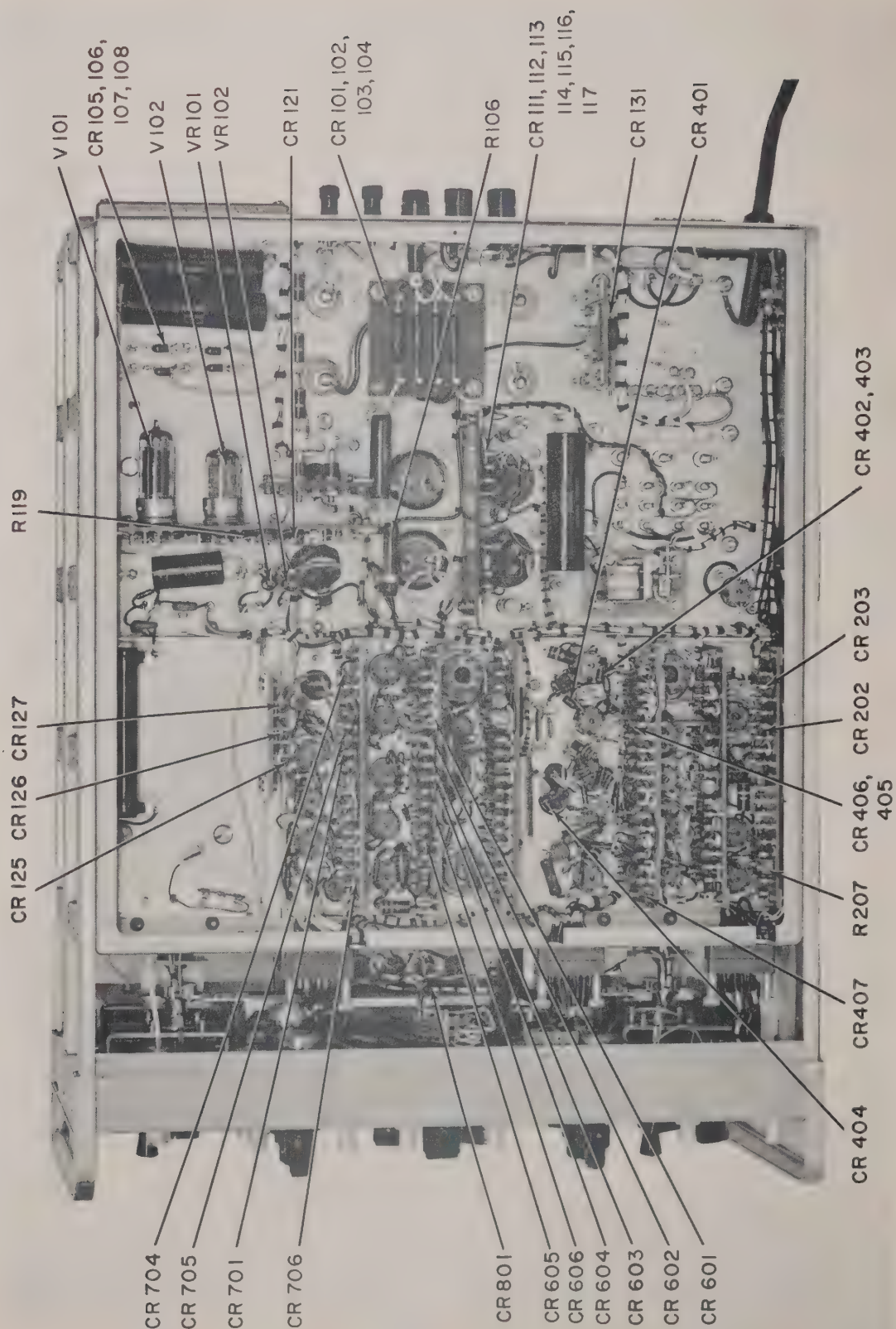


Figure 4-3A. Bottom View of Chassis

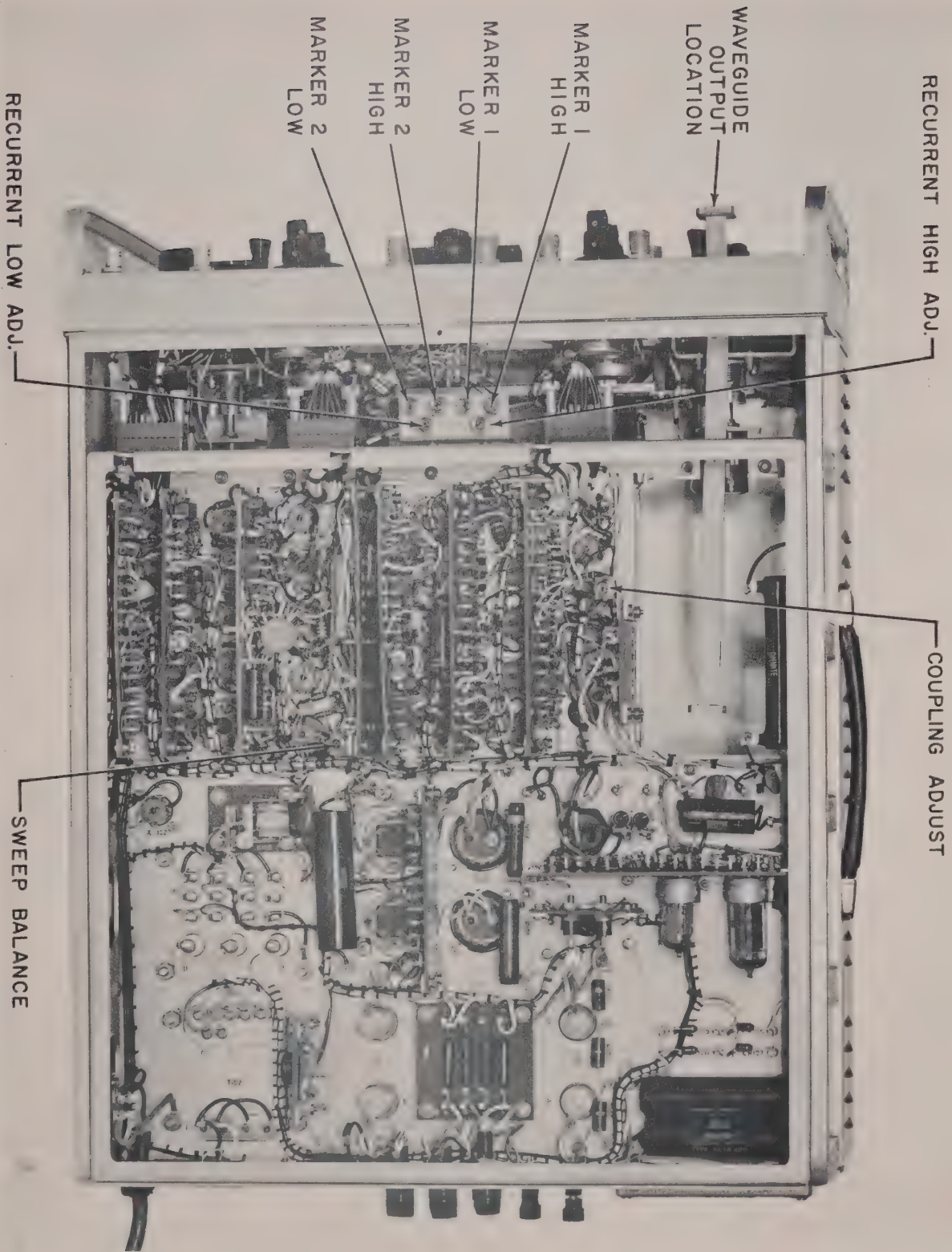


Figure 4-3B. Alternate Bottom View

4-3

TROUBLESHOOTING TABLE

Trouble	Possible Cause	Locating the Cause
1 No Power A Output	No Power to BWO or BWO filament is open	If the Sweeper has been "ON" for some time, the BWO should be warm to the touch. If the BWO is not warm, place the Sweeper in "STANDBY" and remove the BWO connector from its socket. Check voltage between pins C and D of the BWO connector socket for about 7 volts DC. If not present, check wiring. (Remember filament voltage checked out OK in preliminary test.) If voltage was present, check BWO filament continuity with multitester. For an open BWO filament, contact Paradynamics, see Section 7.
B No Power to high voltage circuit		Recheck (-) minus high voltage at pin 9* of V 103. Voltage should be equal to helix voltage listed on BWO data sheet (last page of manual) for the frequency shown. (Select frequency with START Control with SWEEP MODE Selector in "SINGLE".) If voltage doesn't equal the listed voltage, check across terminals 5* and 7* of T 102 for high voltage AC of a value about the same as the maximum listed for the BWO helix. Trace circuit from transformer. Diodes and capacitors are usually the components which short out or open to cause the trouble. NOTE: Before replacing shorted diodes, check nearby capacitors for similar shorts.
C Loss of Anode Voltage		If voltage at pin 9*, V 103 was satisfactory and the BWO output is still not present, check anode to cathode voltage of BWO by testing voltage from pin 1* of V 101 (+) to pin 9* of V 103. Caution: Voltage differential is less than 600 volts DC and is listed on the BWO data sheet, but voltage from either line to ground is high negative DC. Use caution. If voltage is not present, check anode regulator, V 101 and V 102.
D Grid bias beyond cutoff		Measure grid to cathode voltage by checking voltage across CR 127*, again observing caution. Voltage differential should be within normal operating voltage listed on the BWO data sheet. If not, check CR 125* and CR 126* for short or open. Do not test further. Trouble may be in BWO. Return Sweeper to Paradynamics for servicing.

- 2 Loss of Sweep A Loss of Sawtooth in Sweeper
- Place Sweeper in "STANDBY". To reduce sweeprate to a workable value, set the SWEEP RATE Selector to "10-100" or "1-10" and the SWEEP MODE Selector to "RECURRENT". For convenience in measuring, set the START Control to the lowest frequency and the STOP Control to the highest frequency of the Sweeper.
- Measure the voltage at the SWEEP OUTPUT Connectors, CONSTANT and PROPORTIONAL. If 25 volt Sweep is present at both connectors, check the helix regulator, deck 500. If Sweep is not present at either connector, check for No Sweep Generation (No Sawtooth) per section 2B.
- If sawtooth is present at the Constant and not at the Proportional Connector, check V 404, 406 and 405 (in that order). If sawtooth is present at the Proportional and not at the Constant Connector, check V 402A.
- B No Sawtooth Generated
- For no sweep at either Proportional or Constant connector, check V 403 (for input ramps at pins 8 of V 401B and V 402A), V 402B, V 401A and V 402B. Also, check CR 503 for possible short.
- 3 No Leveling A External Troubles
- For Series 880 Sweepers, check output of crystal diode.
- B Leveler Troubles
- Check input to mixer network. If marker controls perform (function) correctly, assume leveler is basically satisfactory and check CR 706. If marker does not "come through" the leveler, check V 703, V 702, V 701, CR 125* and CR 126*.
- 4 Markers Inoperative A Marker Circuit
- If sweep is present and output normal with the exception of the markers, check V 201B and CR 701. If the output is normal and only one marker is operating, check the circuits of the second. For marker #1 operating, check V 603 and 604. Similarly, for marker #2 operating, check V 601 and 602 for fault.

4-4 Comparison Tube Voltages

The following tabulation lists voltages found on the pins of all tubes of a typical Sweeper of this series. Minor variations can be expected. All measurements were made with a 20K ohm/volt meter and referred to ground except as noted.

In using the following table, only compare voltages measured with the Sweeper in the identically same condition as the Sweeper employed in gathering this data.

The conditions of the test were:

- (a) OFF-STANDBY-ON Switch in "STANDBY"
- (b) SWEEP MODE Selector in "RECURRENT"
- (c) SWEEP SELECTOR and CONTROL in "10-100" and full clockwise
- (d) ALC SELECTOR and CONTROL in "OFF" and full clockwise
- (e) AM SELECTOR in "OFF"
- (f) Marker Amplitude full clockwise

Table 4-4
Comparison Voltage Table

Tube	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8	Pin 9
V 101	#-850	#-850	#-550			#-1200	#-850	#-550	#-850
V 102						#-850	#-1080	#-800	
VR 101	-85		GND		-85				
VR 102	-170		-85		-170				
VR 103	GND	-150		-150	GND		-150		
V 203	-155	-165					-165		-45
V 204	-155	-170					-170		-45
V 301			+205	+220	-10			0	
V 302	-10	-85	-85			-85	-170	-170	
V 401	-165	-290	-285			GND	-200	-195	
V 402	+150	-100	-95			+150	-25	-25	
V 403	<u>-75</u>	<u>-150</u>	<u>-150</u>			<u>-100</u>	<u>-150</u>	<u>-150</u>	
V 404	-55	-150	-150			+150	-160	-155	

Tube	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8	Pin 9
V 405	+150	-150	-145			+150	-200	-190	
V 406	GND	-160		-165	-10		-15	+150	
V 407	-250		-160		-250				
V 501	#+150		GND	#-45	#45	GND		#+150	CAP # +1200
V 502	#-45	#-90	#-85			#-90	#-170	#-170	
V 503	#+150	#+2.0	#+3.0			#+150	#-85	#-65	
V 601	(-85)	(-150)	(-150)			(-40)	(-150)	(-150)	
V 602	(+135)	(-85)	(-40)			(-10)	(-40)	(-40)	
V 603	(-40)	(-155)	(-150)			(-60)	(-150)	(-150)	
V 604	(-7)	(-40)	(-35)			(+130)	(-60)	(-35)	
V 605	<u>-150</u>	<u>-310</u>	<u>-295</u>			<u>-115</u>	<u>-315</u>	<u>-295</u>	
V 701	+250	+100	+115			+250	+115	+50	+50
V 702	-4.0	0			+100	+150	0		
V 703	+85	0	+0.5			+140	+85	+85	

NOTES:

Voltages were taken with high voltage "ON"

_____ Voltages were taken with VTVM and SQUARE WAVE Selector in 1000 cps position

() Voltages were taken with Marker #1 at low end and Marker #2 at high end of band.

4-5 The Wave Tube

The Backward Wave Oscillator is factory installed to assure optimum performance. Since all Paradyamics wave tubes are of the permanent magnet type, no field adjustments are required.

4-5-1 Wave Tube Data Sheet

A data sheet, describing all BWO operating parameters, is included at the back of this manual.

4-5-2 Warranty and Replacement

All BWO's are warranted by the tube manufacturer on a pro-rata basis for operating filament life. An internally mounted, direct reading Elapsed Time Meter is provided for recording filament ON time for the BWO. This meter is in parallel with the filament.

In the event of BWO failure, notify Paradyamics, Inc. in writing as soon as possible. Describe in detail the failure, factors which led to it, and the number of operating hours on the tube. A replacement tube, accompanied by complete installation directions, will be provided on a pro-rata basis when the Warranty remains in effect.

4-6 Calibration

In calibrating the Series 880 or 881 Sweeper, all power supplies should first be checked. If voltages are found within tolerance, and ripple values do not disturb (pull) the output, the Sweeper can be calibrated. For excessive ripple, replace power supply tubes, diodes and filter components as necessary.

These procedures will restore a Sweeper to calibration if:

1. The Sweeper has slowly drifted out of calibration...or
2. The Sweeper requires recalibration as a result of changing a component whose characteristics are too far removed from the original equipment characteristic.

For sudden departures from "in tolerance" performance, an actual trouble or fault may exist which cannot be corrected by re-calibration. In this latter event, first troubleshoot the unit.

4-6-1 SWEEP ADJUSTMENTS

For erratic sweep, including dissimilar intensity dots at each end of the sweep (as viewed on a scope), adjust the Recurrent Low Potentiometer, R 404, to sweep evenly. Adjust Recurrent High Potentiometer, R 410, to give equal intensity of dots before and after the sweep (Sweeper should be in RECURRENT mode). Since these pots interact with each other, it may be necessary to re-adjust several times before a satisfactory, well-equalized sweep can be viewed on the scope.

With a wavemeter installed in the output and the Sweeper set on CW output, a ten-point check across the entire band will determine the status of the sweep. If the sweep is linearly displaced all along the band, the entire band can be re-positioned with the Centering Control, R 441. If the first few (low frequency end) graduations do not correspond to the frequencies of the wavemeter...and the remainder of the Sweeper seems to be close to calibration, the Gain Control, R 440, is probably at fault. In resetting the Gain Control, the Centering Control will be affected and should be re-adjusted, too.

NOTE: The following procedure is based on starting with a Sweeper which is only "Out of Calibration" by a very small error. For major inaccuracies, return the Sweeper to Paradynamics, Inc. for complete re-calibration.

To eliminate possible confusion of terms in describing the setting of the Gain Control, let us call the lowest frequency indication of the FREQUENCY DIAL, I-1. The next hairline would then be, I-2, and the third, I-3. Let us also call the actual frequencies which would appear at the output connector for a "within spec" Sweeper, F-1, F-2 and F-3, respectively. Assuming the Sweeper has been found out of calibration, F-1 and I-1 will not correspond...or other frequencies and their indications will not correspond.

To reset the Gain Control, obtain an output of F-1 as read on the wavemeter. Set the START-CW- Δ F Control to read I-2 on the FREQUENCY DIAL. Using only the Centering Control, obtain an output of F-1 (deliberately at a wrong value) at this indication of I-2. (In positioning the START-CW- Δ F Control to indicate I-2, the output frequency will be altered and, therefore, will have to be returned to F-1.) Using the START-CW- Δ F Control, read I-3 on the FREQUENCY DIAL. With the wavemeter set to read F-2, adjust the Gain Control to provide an output from the sweeper of F-2.

Using the START-CW- Δ F Control, obtain an indication of I-1 on the Slide Rule FREQUENCY DIAL. Now, using only the Centering Control, set the output frequency (read on the wavemeter) to F-1. Dial the START-CW- Δ F Control to I-2 and determine the frequency with the wavemeter. If the frequency is F-2, both the Gain and Centering Controls are correctly re-calibrated. If F-2 was not obtained, run through the procedure once more and obtain correspondence between I-2 and F-2 as the final step.

To this point, frequencies higher than the first few hairlines of the Slide Rule FREQUENCY DIAL have been ignored. At this moment, both the GAIN and CENTERING Controls have been re-calibrated and perhaps the remainder of the frequency output is

seriously in error. Two more adjustments can be made...the Shaper High Control (R 443) and Shaper Low Control (R 442). The Shaper, Z501, must be removed (remove one hold-down screw, then lift from its socket) before either Shaper High or Low Potentiometer is adjusted.

Remove the Shaper, Z 501. Couple the probe of the scope onto Pin 7, V 503. Adjust the gain and shift of the scope until the trace cuts the intersection of the top graticule and second vertical index, and cuts the lower graticule and ninth vertical index. The scope is now calibrated. Remove the probe and attach it to the Shaper socket at pin 5. Adjust the Shaper Low Potentiometer, R 442, to coincide the trace with the calibration point on the lower graticule. Transfer the probe to pin 8 of the Shaper Socket and adjust the Shaper High Potentiometer, R 443, to the trace coincides with the upper calibration point. Since the Shaper High and Low Potentiometers interact, several adjustments may be required to achieve the desired results. Eventually, alternating the probe between pins 5 and 8 of the shaper socket will show the trace to fall on the calibration points. Reinstall the Shaper.

Recheck the entire calibration which starts at 4-6-1. This time, minor adjustments to the Shaper High and Low Controls may be made with the Shaper in place.

4-6-2 ΔF BALANCE

Set SWEEP SELECTOR Switch to " ΔF ". Rotate ΔF Vernier Control fully clockwise. Tune wavemeter until pip appears in center of trace...then turn ΔF Vernier counterclockwise to increase sweep width. Re-center wavemeter. Rotate ΔF WIDTH Control clockwise. Adjust ΔF Balance Potentiometer, R 429, (on top deck) to re-center wavemeter. When properly adjusted, the wavemeter will remain in the center of the trace when the ΔF Vernier is turned clockwise and counterclockwise.

4-6-3 MARKER ADJUSTMENT

Connect scope probe to Terminal Board 701, pin 7B, and set the START and STOP Controls (of the Sweeper) to their respective ends of the band. Place the SWEEP MODE Selector in "RECURRENT" and turn up MARKER AMPLITUDE Control by rotating it fully clockwise. Turn Marker 1 Control to read at high end of frequency scale; Marker 2 Control to read at the low end. Adjust Marker 1 potentiometers (High Adjust 1 and Low Adjust 1), R 820 and R 819, till the marker pip trace also falls at the high frequency. Similarly, adjust Marker 2 Potentiometers, R 818 and R 817. Since the Marker 1 High potentiometer interacts with the Marker 1 Low potentiometer...and the two Marker 2 potentiometers also interact...the adjustments will require some back-and-forth manipulation.

After setting both Markers at each end of the frequency dial, crank the Marker 1 Control to the low frequency end...and the Marker 2 Control to the high frequency end. Then repeat the above procedure to bring the marker pips into agreement with the dial indications.

SECTION 5
DATA SHEET AND SCHEMATIC

5-1 Wave Tube Data Sheet

A copy of the data sheet is supplied at the back of this manual for the BWO contained in this particular Sweeper. This sheet describes all tube parameters. In the event of wave tube failure, a replacement tube should be ordered from Paradyamics, Inc.

Replacement tube purchase order must contain the following information:

1. Model Number of Sweeper.
2. Serial Number of Sweeper.
3. Elapsed time registered on the Elapsed Time Meter.
4. Failure mode and factors leading to failure.

5-2 Schematic

The schematic, presented as Fig. 5-1, is on a pull-out sheet for your convenience. Minor differences may appear between the schematic and your particular model of the Sweeper as a result of modification to improve or refine operating parameters. To assure correct correspondence of repair parts, always include the Serial and Model Numbers of the Sweeper with your order. For purposes other than repair parts, the minor differences should cause no concern.

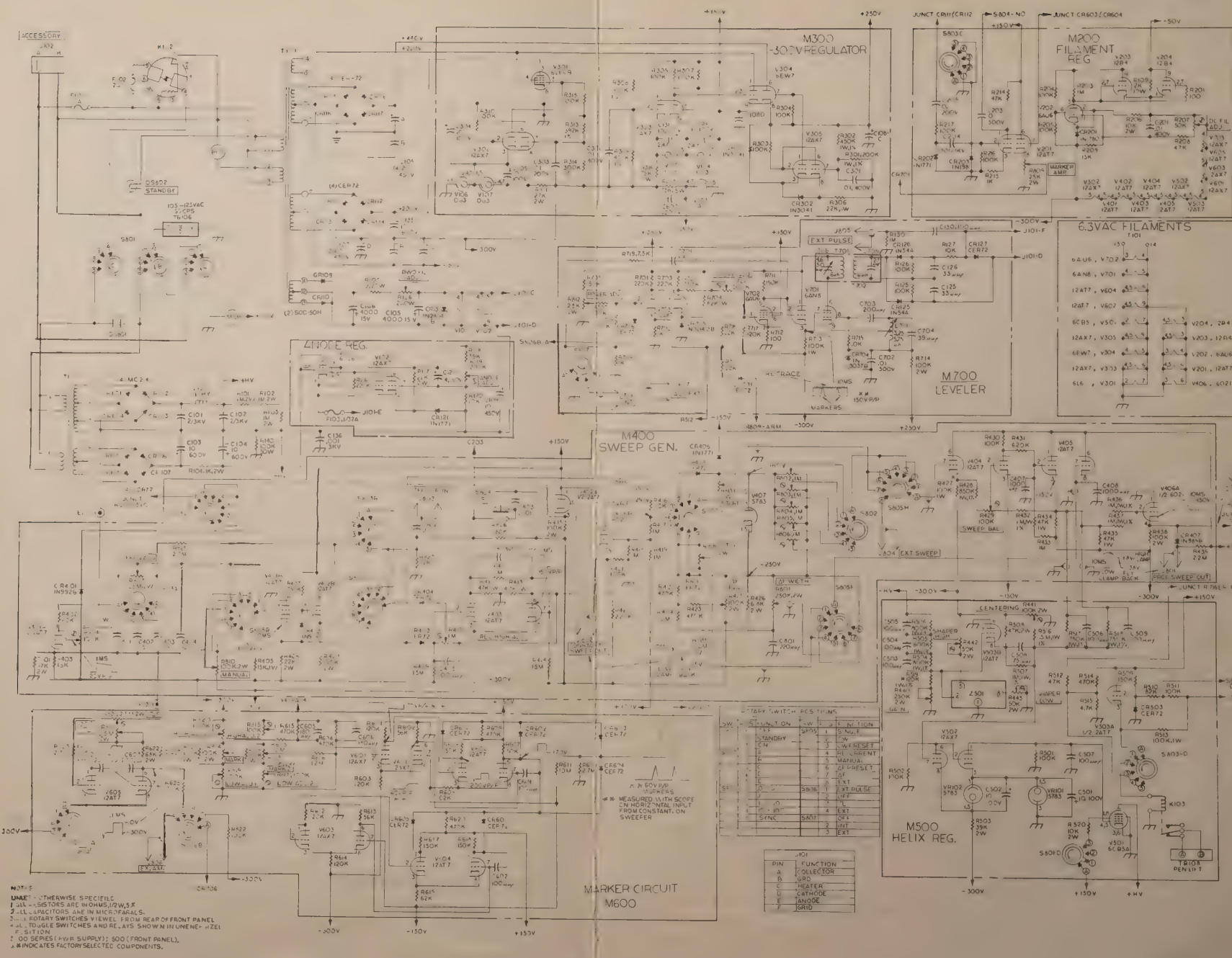


Figure 5-1. Schematic

SECTION 6
PARTS LIST

6-1 General

This parts list identifies all electrical parts used in the Paradyamics Microwave Swept Signal Source, Series 880. The components are listed by designation as noted in Paragraph 1-3.

When ordering replacement parts for the Sweeper, locate the part on the schematic and note its component designation. Then refer to the Component Designation column of this list for the part number and description.

In order to assure delivery of correct parts, list the model number of the Sweeper, component designation, and description of the part.

<u>Component Designation</u>	<u>Description of Part</u>	<u>Manufacturer's Part No.</u>
B 101	Fan, Venturi	Rotron 100-499
C 101	Capacitor, 2uf, 3Kv	Plasticon xoc3MZ
C 102	Capacitor, 2uf, 3Kv	Plasticon xoc3MZ
C 103	Capacitor, 10uf, 600v	CDE BR10-600
C 104	Capacitor, 10uf, 600v	CDE BR10-600
C 105	Capacitor, 4000uf, 15v	SPRAGUE HLBV 4015
C 106	Capacitor, 4000uf, 15v	SPRAGUE HLBV 4015
C 107	Capacitor, 20uf, 450v (4)	CDE DO-130
C 108	Capacitor, 20uf, 450v (4)	CDE DO-130
C 109	Capacitor, 10uf, 450v	CDE BR-10-450
C 115	Capacitor, 0.1uf, 400v	
C 121	Capacitor, 4uf, 150v	CD NLW4-150
C 125	Capacitor, 33uuf, 500v	ELMenco DML5-330G
C 126	Capacitor, 33uuf, 500v	ELMenco DML5-330G
C 130	Capacitor, 100uuf, 6Kv	CENTRALAB DD60-101
C 131	Capacitor, 10uf, 100v	CDE NLW-10-100
C 132	Capacitor, 10uf, 100v	CDE NLW-10-100
C 135	Capacitor, 10uf, 600v	CDE BR-10-600
C 136	Capacitor, 0.001uf, 3Kv	CRL 0030
CR 101	Diode, MC 2-4	
CR 102	Diode, MC 2-4	
CR 103	Diode, MC 2-4	
CR 104	Diode, MC 2-4	
CR 105	Diode, CER 72	
CR 106	Diode, CER 72	

Series 880 & 881
Swept Signal Source

CR 107	Diode, CER 72	
CR 108	Diode, CER 72	
CR 109	Diode, 1N1341	
CR 110	Diode, 1N1341	
CR 111	Diode, CER 72	
CR 112	Diode, CER 72	
CR 113	Diode, CER 72	
CR 114	Diode, CER 72	
CR 115	Diode, CER 72	
CR 116	Diode, CER 72	
CR 117	Diode, CER 72	
CR 118	Diode, CER 72	
CR 121	Diode, 1N1771, 10v, 1w	
CR 125	Diode, 1N54A	
CR 126	Diode, 1N54A	
CR 127	Diode, CER 72	
CR 131	Diode, 1N2804B	
F 101	Fuse, 5A, 125v	LITTLE FUSE 313AG
F 102	Fuse, 2A, 125v	LITTLE FUSE 313AG
F 103	Fuse, 1/32A, 250v	LITTLE FUSE 361AG
K 102	Relay	
K 103	Relay	SIGMA 4F-10000S-SIL
L 101	Choke, 10 Hy	
M 101	Meter, Running Time	CURTIS 4150-1500HR
R 101	Resistor, 1M, 2w, 5%	
R 102	Resistor, 1M, 2w, 5%	
R 103	Resistor, 1M, 2w, 5%	
R 104	Resistor, 1K, 2w, 5%	
R 105	Resistor, 2 ohms, 20w	OHMITE BROWN DEVIL
R 106	Potentiometer, 2 ohms, 10w	OHMITE BROWN DEVIL
R 107	Resistor, 7.5K, 5w	OHMITE BROWN DEVIL
R 109	Resistor, 2K, 10w, 5%	OHMITE BROWN DEVIL 1742
R 116	Resistor, 220K, $\frac{1}{2}$ w, 5%	
R 117	Resistor, 22K, 2w, 5%	
R 118	Resistor, 39K, $\frac{1}{2}$ w, 5%	
R 119	Potentiometer, 200K, 0.2w	BOURNS 272-1-204
R 120	Resistor, 10K, $\frac{1}{2}$ w, 5%	
R 125	Resistor, 100K, $\frac{1}{2}$ w, 5%	
R 126	Resistor, 100K, $\frac{1}{2}$ w, 5%	
R 127	Resistor, 10K, $\frac{1}{2}$ w, 5%	
R 130	Resistor, 1M, $\frac{1}{2}$ w, 5%	
R 140	Resistor, 100K, 50w	OHMITE D422
T 101	Transformer	
T 102	Transformer	

V 101	Tube, 6CL6	
V 102	Tube, 12AX7	
V 103	Tube, 0A2	
V 104	Tube, OG3	
V 105	Tube, OG3	
V 106	Tube, OG3	
V 107	Tube, OG3	
VR 101	Voltage Regulator, 5783	
VR 102	Voltage Regulator, 5783	
W 101	Line Cord	BIRNBACH 346
C 201	Capacitor, 0.01uf, 400v	HOPKIN GAA 4P1
C 203	Capacitor, 0.01uf, 500v	SPRAGUE 5HK-S10
C 204	Capacitor, 0.001uf, 1Kv	SPRAGUE 5HK-D10
C 205	Capacitor, 0.1uf, 200v	AEROVOX P8292ZN10
CR 201	Diode, 1N1780	
CR 202	Diode, 1N1771	
CR 203	Diode, 1N198	
R 201	Resistor, 100 ohms, $\frac{1}{2}$ w, 5%	
R 203	Resistor, 1M, $\frac{1}{2}$ w, 5%	
R 204	Resistor, 100K, $\frac{1}{2}$ w, 5%	
R 205	Resistor, 100K, $\frac{1}{2}$ w, 5%	
R 206	Resistor, 10K, 2w, 5%	
R 207	Potentiometer, 50K, 0.2w	BOURNS 272-1-50B
R 208	Resistor, 47K, $\frac{1}{2}$ w, 5%	
R 209	Resistor, 15K, $\frac{1}{2}$ w, 5%	
R 214	Resistor, 47K, $\frac{1}{2}$ w, 5%	
R 215	Resistor, 1K, $\frac{1}{2}$ w, 5%	
R 216	Resistor, 100K, $\frac{1}{2}$ w, 5%	
R 217	Resistor, 100K, $\frac{1}{2}$ w, 5%	
V 201	Tube, 12AT7	
V 202	Tube, 6AU6	
V 203	Tube, 12B4	
V 204	Tube, 12B4	
C 301	Capacitor, 0.1uf, 400v	HOPKINS GAA 4P1
C 302	Capacitor, 0.1uf, 400v	HOPKINS GAA 4P1
C 303	Capacitor, 0.1uf, 200v	SPRAGUE 5HK-P10
C 304	Capacitor, 10uf, 100v	CDE NLW-10-100
C 305	Capacitor, 10uf, 100v	CDE NLW-10-100
CR 301	Diode, 1N3041	
CR 302	Diode, 1N3041	

Series 880 & 881
Swept Signal Source

R 301	Resistor, 200K, 1w, 1%	
R 302	Resistor, 450K, 1w, 1%	
R 303	Resistor, 100K, $\frac{1}{2}$ w, 5%	
R 304	Resistor, 100K, $\frac{1}{2}$ w, 5%	
R 305	Resistor, 100K, $\frac{1}{2}$ w, 5%	
R 306	Resistor, 22K, 1w, 5%	
R 307	Resistor, 100K, $\frac{1}{2}$ w, 5%	
R 308	Resistor, 300K, $\frac{1}{2}$ w, 1%	
R 309	Resistor, 499K, $\frac{1}{2}$ w, 1%	
R 310	Resistor, 100K, $\frac{1}{2}$ w, 5%	
R 311	Resistor, 27K, 2w, 5%	
R 313	Resistor, 392K, $\frac{1}{2}$ w, 1%	
R 314	Resistor, 300K, $\frac{1}{2}$ w, 1%	
R 315	Resistor, 100K, $\frac{1}{2}$ w, 5%	
R 316	Resistor, 75K, 2w, 5%	
V 301	Tube, 6L6GB	
V 302	Tube, 12AX7	
V 303	Tube, 12AX7	
V 304	Tube, 6EW7	
V 305	Tube, 12AX7	
C 401	Capacitor, 5uf, 150v	SPRAGUE 121P50591R5S4
C 402	Capacitor, 0.5uf, 200v	SPRAGUE 155P5-200
C 403	Capacitor, 0.05uf, 500v	SPRAGUE 5HK-S50
C 404	Capacitor, 0.005uf, 1Kv	SPRAGUE 5HK-D50
C 405	Capacitor, 100uuf, 500v	ELMENCO DM10-101G
C 406	Capacitor, 1000uuf, 500v	ELMENCO DM10-101G
C 407	Capacitor, 1000uuf	ELMENCO DM15-102G
C 408	Capacitor, 1000uuf	ELMENCO DM15-102G.
CR 401	Diode, 1N992B	
CR 402	Diode, 1N989	
CR 403	Diode, CER 72	
CR 404	Diode, CER 72	
CR 405	Diode, CER 72	
CR 406	Diode, 1N1771	
CR 407	Diode, 1N989B	
R 401	Resistor, 47K, 2w, 5%	
R 402	Resistor, 62K, $\frac{1}{2}$ w, 5%	
R 403	Resistor, 1.8K, $\frac{1}{2}$ w, 5%	
R 404	Potentiometer, 100K, 0.2w	RV6LAY5A104A
R 405	Resistor, 15K, 1w, 5%	
R 406	Resistor, 22K, 2w, 5%	
R 407	Resistor, 750K, $\frac{1}{2}$ w, 5%	
R 408	Resistor, 100K, 2w, 5%	
R 409	Resistor, 1.5M, $\frac{1}{2}$ w, 5%	
R 410	Potentiometer, 1M	RV6LAYSAL05A
R 411	Resistor, 47K, 1w, 5%	

R 412	Resistor, 1M, $\frac{1}{2}w$, 5%	
R 413	Resistor, 47K, 1w, 5%	
R 414	Resistor, 1.5M, $\frac{1}{2}w$, 5%	
R 415	Resistor, 100K, 2w, 5%	
R 416	Resistor, 10K, $\frac{1}{2}w$, 5%	
R 417	Resistor, 1M, $\frac{1}{4}w$, 5%	
R 418	Resistor, 1M, $\frac{1}{4}w$, 5%	
R 419	Resistor, 1M, $\frac{1}{2}w$, 5%	
R 420	Resistor, 220K, $\frac{1}{4}w$, 5%	
R 421	Resistor, 100K, $\frac{1}{4}w$, 5%	
R 422	Resistor, 470K, $\frac{1}{4}w$, 5%	
R 423	Resistor, 470K, $\frac{1}{4}w$, 5%	
R 424	Resistor, 1.2M, $\frac{1}{2}w$, 5%	
R 425	Potentiometer, 100K, 2w	OHMITE CLV1041
R 426	Resistor, 6.8K, 2w, 5%	
R 427	Resistor, 100K, 1w, 5%	
R 428	Resistor, 850K, 1w, 1%	
R 429	Potentiometer, 100K	LOGAN 5ST
R 430	Resistor, 100K, $\frac{1}{4}w$, 5%	
R 431	Resistor, 620K, $\frac{1}{2}w$, 5%	
R 432	Resistor, 1M, 1w, 1%	
R 433	Resistor, 1M, $\frac{1}{2}w$, 5%	
R 434	Resistor, 47K, 1w, 5%	
R 435	Resistor, 47K, 1w, 5%	
R 436	Resistor, 1M, 1w, 1%	
R 437	Resistor, 1M, 1w, 1%	
R 438	Resistor, 100K, 2w, 5%	
R 439	Resistor, 2.2M, $\frac{1}{2}w$, 5%	
R 440	Potentiometer, 250K, 2w	LOGAN B11
R 441	Potentiometer, 100K, 2w	LOGAN B11
R 442	Potentiometer, 50K, 2w	LOGAN B11
R 443	Potentiometer, 50K, 2w	LOGAN B11
R 444	Resistor, 100K, $\frac{1}{2}w$, 5%	
V 401	Tube, 12AT7	
V 402	Tube, 12AT7	
V 403	Tube, 12AT7	
V 404	Tube, 12AT7	
V 405	Tube, 12AT7	
V 406	Tube, 6021	
V 407	Tube, 5783	
C 501	Capacitor, 10uf, 100v	
C 502	Capacitor, 10uf, 100v	
C 503	Capacitor, 100uuf, 500v	
C 504	Capacitor, 100uuf, 500v	
C 505	Capacitor, 100uuf, 500v	
C 506	Capacitor, 100uuf, 500v	
C 507	Capacitor, 100uuf, 500v	ARCO DM 15-101-G
C 508	Capacitor, 75 uuf	
C 509	Capacitor, 100uuf	

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CR 503

Diode, CER 72

R 501	Resistor, 100K, $\frac{1}{2}w$, 5%
R 502	Resistor, 100K, $\frac{1}{2}w$, 5%
R 503	Resistor, 39K, 2w, 5%
R 504	Resistor, 800K, 1w, 1%
R 505	Resistor, 800K, 1w, 1%
R 506	Resistor, 800K, 1w, 1%
R 507	Resistor, 1M, 1w, 1%
R 508	Resistor, 47K, 2w, 5%
R 509	Resistor, 150K, $\frac{1}{2}w$, 5%
R 510	Resistor, 82K, $\frac{1}{2}w$, 5%
R 511	Resistor, 100K, $\frac{1}{2}w$, 5%
R 512	Resistor, 47K, $\frac{1}{2}w$, 5%
R 513	Resistor, 100K, 1w, 5%
R 514	Resistor, 470K, $\frac{1}{2}w$, 5%
R 515	Resistor, 3.3K, $\frac{1}{2}w$, 5%
R 516	Resistor, 1.5M, 1w, 1%
R 517	Resistor, 750K, 1w, 1%
R 518	Resistor, 750K, 1w, 1%
R 519	Resistor, 120K, 1w, 1%
R 520	Resistor, 10K, 2w, 5%

V 501

Tube, 6CB5-A

V 502

Tube, 12AX7

V 503

Tube, 12AT7

Z 501

Shaping Network

C 601	Capacitor, 100uuf, 500v	ELMenco DM15-101-G
C 602	Capacitor, 100uuf, 500v	ELMenco DM15-101-G
C 603	Capacitor, 200uuf, 1Kv	SPRAGUE NPO-10TCC-T20
C 604	Capacitor, 200uuf, 1Kv	SPRAGUE NPO-10TCC-T20
C 605	Capacitor, 180uuf, 500v	ELEMCO DM-15-181G
C 606	Capacitor, 180uuf, 500v	ELEMCO DM-15-181G
C 607	Capacitor, 1.0uf, 200v	

CR 601

Diode, CER 72

CR 602

Diode, CER 72

CR 603

Diode, CER 72

CR 604

Diode, CER 72

CR 605

Diode, CER 72

CR 606

Diode, CER 72

R 601

Resistor, 120K, $\frac{1}{2}w$, 5%

R 602

Resistor, 56K, $\frac{1}{2}w$, 5%

R 603

Resistor, 470K, $\frac{1}{2}w$, 5%

R 605

Resistor, 1.2M, $\frac{1}{2}w$, 5%

R 606

Resistor, 150K, $\frac{1}{2}w$, 5%

R 607

Resistor, 150K, $\frac{1}{2}w$, 5%

R 608	Resistor, 62K $\frac{1}{2}$ W, 5%	
R 609	Resistor, 470K, $\frac{1}{4}$ W, 5%	
R 610	Resistor, 2.7M, $\frac{1}{2}$ W, 5%	
R 611	Resistor, 10M, $\frac{1}{2}$ W, 5%	
R 612	Resistor, 120K, $\frac{1}{2}$ W, 5%	
R 613	Resistor, 56K, $\frac{1}{2}$ W, 5%	
R 614	Resistor, 120K, $\frac{1}{2}$ W, 5%	
R 615	Resistor, 470K, $\frac{1}{4}$ W, 5%	
R 616	Resistor, 1.2M, $\frac{1}{4}$ W, 5%	
R 617	Resistor, 150K, $\frac{1}{4}$ W, 5%	
R 618	Resistor, 150K, $\frac{1}{2}$ W, 5%	
R 619	Resistor, 62K, $\frac{1}{2}$ W, 5%	
R 620	Resistor, 470K, $\frac{1}{2}$ W, 5%	
R 621	Resistor, 68K, 2W, 5%	
R 622	Resistor, 68K, 2W, 5%	
R 623	Resistor, 2.7M, $\frac{1}{4}$ W, 5%	
R 624	Resistor, 2.7M, $\frac{1}{4}$ W, 5%	
R 625	Resistor, 100K, $\frac{1}{2}$ W, 5%	
V 601	Tube, 12AX7	
V 602	Tube, 12AT7	
V 603	Tube, 12AX7	
V 604	Tube, 12AT7	
V 605	Tube, 12AT7	
C 701	Capacitor, 68uuf, 500v	ELMenco DM10-680-G
C 702	Capacitor, 0.01uf, 500v	SPRAGUE 5HK-S10
C 703	Capacitor, 200uuf, 500v	ELMenco DM15-201G
C 704	Capacitor, 39uuf, 500v	ELMenco DM15-390G
C 705	Capacitor, 27uuf, 500v	ELMenco DM15-270G
C 706	Capacitor, variable, 4.6-50uuf	JOHNSON 158-3 TYPE K
C 707	Capacitor, 0.01uf, 500v	SPRAGUE 5HK-S10
CR 701	Diode, CER 72	
CR 704	Diode, 50v, 1w, 1N3037B	
CR 705	Diode, 1N3042B	
CR 706	Diode, CER 72	
L 701	Coil, 3.25-5.75uH	
R 701	Resistor, 220K, $\frac{1}{2}$ W, 5%	
R 702	Resistor, 1K, $\frac{1}{2}$ W, 5%	
R 703	Resistor, 220K, $\frac{1}{2}$ W, 5%	
R 704	Resistor, 82K, 1W, 5%	
R 705	Resistor, 150K, $\frac{1}{2}$ W, 5%	
R 707	Resistor, 100K, $\frac{1}{2}$ W, 5%	
R 708	Resistor, 10K, $\frac{1}{2}$ W, 5%	
R 709	Resistor, 1K, $\frac{1}{2}$ W, 5%	
R 711	Resistor, 150K, $\frac{1}{2}$ W, 5%	
R 712	Resistor, 100 ohms, $\frac{1}{2}$ W, 5%	

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R 713	Resistor, 100K, 1w, 5%	
R 714	Resistor, 100K, 2w, 5%	
R 715	Resistor, 10K, $\frac{1}{2}$ w, 5%	
R 716	Resistor, 22K, $\frac{1}{2}$ w, 5%	
R 717	Resistor, 820K, $\frac{1}{2}$ w, 5%	
R 718	Resistor, 22K, $\frac{1}{2}$ w, 5%	
R 719	Resistor, 7.5K, $\frac{1}{2}$ w, 5%	
R 720	Resistor, 750K, $\frac{1}{2}$ w, 5%	
R 721	Potentiometer, 500K	RV6LAYS A504A
T 701	Coil	
T 702	Coil	
V 701	Tube, 6AN8	
V 702	Tube, 6AU6	
V 703	Tube, 12AX7	
C 801	Capacitor, 220uuf	ARCO DM10221G
C 802	Capacitor, 0.001uf	
C 803	Capacitor, 0.001uf	
CR 801	Diode, CER 72	
DS 801	Pilot Light	
DS 802	Pilot Light	
R 801	Potentiometer, 250K, 2w	Part of S 802, OHMITE CU251
R 802	Potentiometer, 1M, 0.2w	BOURNS 272-1-105
R 803	Potentiometer, 1M, 0.2w	BOURNS 272-1-105
R 804	Potentiometer, 1M, 0.2w	BOURNS 272-1-105
R 805	Potentiometer, 1M, 0.2w	BOURNS 272-1-105
R 806	Potentiometer, 1M, 0.2w	BOURNS 272-1-105
R 807	Potentiometer, 25M, 2w	Part of S 803, AB TYPE J,
R 809	Potentiometer, 25K, 2w	LOG TAPER
R 810	Potentiometer, 100K, 2w	
R 811	Potentiometer, 2.5M, 2w	Part of S 806, OHMITE
R 812	Potentiometer, 2.5K, 2w	Part of S 807, OHMITE, CU251
R 813	Potentiometer, 1 Meg	Daystron 349-113
R 814	Potentiometer, 100K, 2w	BORG 205
R 815	Potentiometer, 100K, 2w	BORG 205
R 816	Potentiometer, 1 Meg	Daystron 349-113
R 817	Potentiometer, 100K, 0.2w	RV6LAYS A104A
R 818	Potentiometer, 100K, 0.2w	RV6LAYS A104A
R 819	Potentiometer, 100K, 0.2w	RV6LAYS A104A
R 819	Potentiometer, 100K, 0.2w	RV6LAYS A104A
R 820	Potentiometer, 100K, 0.2w	RV6LAYS A104A
R 821	Potentiometer, 2.5M, 2w	
R 822	Resistor, 100K, $\frac{1}{2}$ w, 5%	Part of S 806
R 823	Resistor, 100K, $\frac{1}{2}$ w, 5%	
R 825	Resistor, 2.7M, $\frac{1}{2}$ w, 5%	

R 826	Resistor, 180K, $\frac{1}{2}$ w, 5%
R 827	Resistor, 82K, $\frac{1}{2}$ w, 5%
R 828	Resistor, 100K, 1w, 5%
R 829	Resistor, 100K, 1w, 5%

S 801	Switch, Rotary	OAK MFG CO
S 802	Switch, Rotary	OAK MFG CO
S 803	Switch, Rotary	OAK MFG CO
S 804	Switch, Pushbutton	H. H. SMITH 556
S 805	Switch, Rotary	OAK MFG CO
S 806	Switch, Rotary	OAK MFG CO
S 807	Switch, Rotary	OAK MFG CO

SECTION 7

WARRANTY

7-1 Warranty

Paradynamics, Incorporated warrants each Series 880 and 881 Sweeper to be free from defects in material and workmanship. Our liability under this warranty is limited to servicing or adjusting any instrument returned to our plant for that purpose and to replace any defective parts therein. This warranty is effective for one year following delivery to the original purchaser, except as noted, provided the instrument is returned transportation charges prepaid by the original purchaser, and subject to our examination. For tubes, fuses and batteries, the warranty period shall be thirty (30) days. If the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed at cost and upon request, an estimate will be submitted before repairs are started. The wave tube, covered by the tube manufacturer's warranty, is not further warranted by Paradynamics.

Paradynamics, Incorporated reserves the right to make changes in design at any time without incurring any obligation to install said changes on units previously purchased.

7-2 Damage in Shipment

All instruments sent by public carrier are packaged in special cartons designed to protect the instrument in transit. After receipt of the instrument, the following procedure is authorized:

- (1) Before removing instrument from packing case, inspect for obvious damage. If damage is apparent, have carrier inspect the package. A copy of his report should accompany the properly executed form located at the end of this Manual.
- (2) If no apparent damage is visible, the instrument should be tested as soon as possible. If it fails to operate properly, a claim must be filed with the carrier. A copy of the carrier's report should accompany the properly executed form located at the end of this Manual.

Upon receipt of appropriate documents, Paradynamics, Inc. will arrange for repair or replacement. If return shipment is authorized, forward the instrument prepaid.

7-3 Repairs Under Warranty

If any fault develops in the operation of the instrument, the following procedure is authorized:

- (1) Notify Service Department, Paradyamics, Inc., Huntington Station, L. I., N. Y., immediately by mailing the form located at the end of this Manual. Be certain to include a detailed description of the difficulty. Upon receipt of the form, Paradyamics will arrange for repair or replacement.
- (2) If return shipment is authorized, forward the instrument prepaid.

7-4 Repairs Not Under Warranty

- (1) Same as (1) and (2) above.
- (2) Repairs not covered by warranty will be billed at cost. If requested, an estimate of the charges will be made before repairs are started.

NOTE: DO NOT RETURN EQUIPMENT TO THE FACTORY WITHOUT WRITTEN AUTHORIZATION.

PARADYNAMICS, INCORPORATED
Huntington Station, New York
(516) HAmilton 7-7961

REQUEST FOR MAINTENANCE

FROM:

COMPANY NAME _____	DATE _____
ADDRESS _____	INDIVIDUAL _____
_____	POSITION _____
SECTION OR DIVISION _____	PHONE NO. _____ EXT. _____
EQUIPMENT _____	DATE OF PURCHASE _____
MODEL _____ SERIAL NO. _____	ORDER NO. _____

TROUBLE REPORT:

A. Description of trouble _____

B. Has trouble been localized? _____ If so, where and how _____

C. Instruments used and measurements taken, if any _____

D. Is trouble intermittent? _____

E. Hours of operation prior to this trouble _____

F. Date trouble occurred _____

G. Was factory consulted by telephone or letter prior to this request? _____

If so, give date and person to whom directed: _____

H. Additional Comments _____

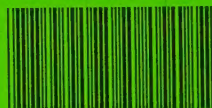
When trouble develops requiring factory assistance, complete this form and send to:

PARADYNAMICS, INCORPORATED
Huntington Station, New York
Attention: Service Department

After this report has been analyzed by the Service Department, you will be notified when a field service engineer will make the necessary repairs. If your trouble can best be corrected at the factory, we will so notify you, with instructions and authorization for returning the equipment.

NO EQUIPMENT MAY BE RETURNED TO THE FACTORY WITHOUT WRITTEN AUTHORIZATION

MP MASTER



MA23326